A star (✱) indicates that the Abstract deals with Apparatus and Instruments.

JANUARY, 1939.

GENERAL PHYSICS.

ATOMIC AND MOLECULAR STRUCTURE.

1. Structure of Matter. Part II. G. Fournier. *J. de. Physique et le Radium*, 9. *pp.* 360–376, *Sept.*, 1938.—The problem is to fill space with regular convex bodies. The only possibilities are (*a*) cubes, (*b*) a mixture of octahedra and tetrahedra. The possible relationships between the octahedra and tetrahedra are discussed. [For Part I see Abstract 4270 (1938).] H. G. C.

2. Nuclei, Stable and Radioactive. R. Grégoire. *J. de Physique et le Radium*, 9. *pp.* 419–427, *Oct.*, 1938.—From existing literature a list has been compiled of all the nuclei of stable or radioactive atoms at present known. Under each atomic number is listed all the known isotopes, natural or artificial, the proportions of the natural isotopes, and the period and types of radiation associated with the radioactive isotopes. K. M. C.

3. Theory of Heavy Nuclei. Part I. Neutron Excess in Heavy Nuclei. Part II. Decrease of Gamow Barrier Owing to Excitation. E. Bagge. *Ann. d. Physik*, 33. 4. *pp.* 359–388, *Oct., and* 33. 5. *pp.* 389–403, *Nov.*, 1938.—The interaction energy between nuclear particles is assumed to be of the shape of a "Gaussian" curve. The spin dependence of the force is arranged in such a way that the force is twice as strong in the triplet state of the deuteron as it is in the singlet state. Otherwise the dependence on the nature of the particle and the exchange character of the force are left undetermined The binding energy of a heavy nucleus is then calculated, treating the interaction between the particles by a perturbation method, up to the second order of approximation. The results are used to calculate the excess of the number of neutrons over that of protons in the most stable isobare, the radius and the total energy. These values are compared with experiment. The method is not accurate enough to determine from this comparison the nature of the forces completely, but it is possible to say that certain assumptions about the forces appear to be more probable than others. The "thermal" vibrations of a heavy nucleus are then discussed, assuming the nucleus to vibrate like an incompressible liquid, and the escape of a proton from such a highly excited nucleus is discussed. It is found that the effective height of the Gamow barrier is reduced by only about 1 MV. This is insufficient to explain the presence of slow protons in nuclear explosions produced by cosmic rays. R. P.

4. Statistical Theory of Nuclei. J. Solomon. *Comptes Rendus*, 207. *pp.* 910–911, *Nov.* 14, 1938.—Limitations of the application of the Fermi-Thomas statistics are examined. Some uncertainty in the case of light nuclei is indicated. N. M. B.

5. Passage of Particles Through Coulomb Potential Barriers. G. Badarau. *Comptes Rendus*, 207. *pp.* 842–845, *Nov.* 7, 1938.—An exact solution of a problem previously examined [see Abstract 3432 (1938)] is deduced for the special case of a Coulomb potential. N. M. B.

6. Symmetry Effects in Spacing of Nuclear Energy Levels. J. Bardeen and E. Feenberg. *Phys. Rev.* 54. *pp.* 809–818, *Nov.*, 1938.—The results of Wigner [see **Abstracts 414 and 2873** (1937)] on mass defects and stability relations make possible a calculation of level density for intermediate nuclei ($A < 60$) which takes properly into account the dependence of nuclear energies on symmetry character. In general, a configuration of neutrons and protons in single-particle orbits contains many different types of symmetry compatible with the exclusion principle. The various symmetry types arising from one configuration all have the same kinetic energy, but differ in potential energy; decreasing symmetry (increasing number of nodes) is associated with decreasing potential energy. Level densities for the different nuclear types are tabulated. The results indicate a marked increase of density for increasing isotopic number of an isobaric series. Transmutation experiments on isobares should make possible a test of the theory. AUTHORS.

7. Rigorous Theory of Interaction Between Nuclear Particles. E. C. G. Stueckelberg. *Phys. Rev.* 54. *pp.* 889–892, *Dec.* 1, 1938.—The static interaction between elementary particles can be introduced in the Hamiltonian by way of a contact transformation. In classical theory no serious difficulties arise. However, in quantum theory of radiation divergent terms appear. AUTHOR.

8. Stereochemistry of Quadricovalent Atoms: Thallium. E. G. Cox, A. J. Shorter and W. Wardlaw. *Chem. Soc., J. pp.* 1886–1888, *Nov.*, 1938.—From the small separation of Tl atoms found by X-ray analysis of tetrakisthioureathallous nitrate and chloride it is inferred that if, as the chemical evidence indicates, these are typical 4-coordinated compounds of the type $[\mathrm{TlR_4}]\mathrm{X}$, then the four valencies of the thallous atom are coplanar. The data for dimethylthallic acetylacetone, which has also been studied, are less conclusive, but are in agreement with the view that the four valencies of tervalent thallium are distributed tetrahedrally. AUTHORS.

9. Structures and Dipole Moments of Chlorosilanes and Chloro- and Bromo-Acetylene. L. O. Brockway and I. E. Coop. *Faraday Soc., Trans.* 34. *pp.* 1429–1439, *Dec.*, 1938.—The molecular structures of $\mathrm{SiH_3Cl}$, $\mathrm{SiH_2Cl_2}$, $\mathrm{SiHCl_3}$, CHCBr and CH.CCl have been measured by electron diffraction and polarisation measurements on the vapours. The Si—Cl bond lengths in $\mathrm{SiH_3Cl}$ and $\mathrm{SiH_2Cl_2}$ are $2{\cdot}06 \pm 0{\cdot}05$ Å and $2{\cdot}02 \pm 0{\cdot}03$ Å respectively, with $>$ ClSiCl $= 110 \pm 1°$ in the latter molecule. In $\mathrm{SiHCl_3}$ (measured previously) the Si—Cl distance is $2{\cdot}01 \pm 0{\cdot}03$ Å, and $<$ ClSiCl $= 110 \pm 1°$. These distances are shorter than the radius sum for a single covalent Si—Cl bond, 2·16 Å. The dipole moments are $\mathrm{SiH_3Cl}$, 1·28 D.; $\mathrm{SiH_2Cl_2}$, 1·17 D.; and $\mathrm{SiHCl_3}$, 0·85 D. A comparison of these structures and moments with those of the chloromethanes shows that the polarity of the Si—Cl bonds does not affect their lengths. Both the bond moments and lengths appear to be affected by a partial back coordination or degree of double bond character in the Si—Cl link, and this effect is the most important of the factors previously discussed in relation to the deviation of Si—Cl bonds from the normal covalent single type. The moments of CH·CCl and CH·CBr are 0·44 D. and 0·00 D. These small values when compared with the moments of the methyl halides lead to "mesomeric" moments of 1·6 and 2·0 D. The bond distances (C—Cl $= 1{\cdot}68 \pm 0{\cdot}04$ D. and C—Br $= 1{\cdot}80 \pm 0{\cdot}03$ Å) are 0·08 A. and 0·11 Å. shorter than in the corresponding halogenomethanes, but are

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not as short as would be expected from the large mesomeric effect shown by the observed moments. AUTHORS.

10. Structure and Dipole Moments of Ethylene Derivatives. J. A. C. Hugill, I. E. Coop and L. E. Sutton. *Faraday Soc., Trans.* 34. *pp.* 1518–1534, *Dec.*, 1938.—Measurements of electric dipole moment and of interatomic distances (by electron diffraction) have been made on several halogeno-ethylenes. Vinyl chloride, vinyl bromide and vinyl iodide have moments of 1·44, 1·41, and 1·26 D. respectively. In vinyl bromide and *trans*-acetylenedibromide the C—Br distance is 1·86 ± 0·04 Å., and the Br—C—C angle is 121 ± 3°. In the latter the Br—Br distance is 4·56 ± 0·02 Å. In vinyl iodide, and the *trans*- and *cis*-acetylene *di*-iodides, the C—I distance is 2·03 ± 0·04 Å.; in the first two substances the I—C—C angle is 122 ± 2°, but in the third it is 125 ± 2°. In the *trans*-di-iodide the I—I distance is 4·90 ± 0·02 Å., in the *cis* one 3·69 ± 0·02 Å. In none of these compounds was it possible to make an independent determination of the C = C distance, which was therefore assumed to be 1·34 Å. The value of these results as evidence for "resonance" in the molecules has been examined and the discussion has been extended to include halogeno-derivatives of other unsaturated systems. It was concluded that neither bond contactions nor electric dipole moment anomalies can give accurate absolute measures of the part which excited structures play in the actual molecule, but that they can give useful comparative data in certain series of compounds. This being so, it was concluded that the data for the vinyl halides agree with the hypothesis that there is resonance between the normal structure $H_2C = CH—Hal$ and the excited one $H_2\overset{-}{C}—CH = \overset{+}{Hal}$, the former being about nine times as important as the latter. AUTHORS.

11. Energy of H_3 and H_3^+. J. O. Hirschfelder. *J. Chem. Phys.* 6. *pp.* 795–806, *Dec.*, 1938.—In previous papers [see Abstract 12 (1938)] the energy of H_3 and H_3^+ has been obtained by the variational method for linear configurations. In this treatment the authors are able to evaluate the difficult three centre integrals for nonlinear configurations with the aid of the differential analyser and to compute the energy of H_3 and H_3^+ as a function of the angle between the nuclei. The excited states as well as the ground states are considered. Direct comparison of calculated energy values for the equilateral triangle show that the molecular orbital approximation is inferior to the method of homopolar bond functions. H_3 has its lowest energy for linear configurations. The angle dependence calculated by the variational method agrees well with that calculated on the basis of the Eyring semi-empirical scheme. By the theroem of Jahn and Teller there could not be a minimum in the energy for the equilateral triangle, as here the lowest electronic state is doubly degenerate. H_3^+ is very stable (when left to itself) and has an energy lower by more than 184 kg. cal. than two separated H atoms and a proton. Thus the chemical reaction: $H_2 + H_2^+ \rightarrow H_3^+ + H$ is certainly exothermic by more than 11 kg. cal. and probably is exothermic by 38 kg. cal. H_3^+ has a stable configuration corresponding to separation between the nuclei of about 1·79 Å with the nuclei lying intermediate between a right and an equilateral triangle. The vibration frequencies of H_3^+ are estimated but their exact value as well as the exact configuration of the stable state are somewhat in doubt. Two of these frequencies should be infra-red active and susceptible to direct experimental measurement. AUTHOR.

12. Integrals Required for Computing the Energy of H_3 and of H_3^+. J. O. Hirschfelder and C. N. Weygandt. *J. Chem. Phys.* 6. *pp.* 806–810, *Dec.*, 1938.—Some of the difficult integrals required for the variational method calculation of the energy of H_3 and H_3^+ were evaluated with the aid of the differential analyser. The integral $\int_0^\pi \exp(-B(1-A\cos\theta)^{\frac{1}{2}})d\theta$ is tabulated for a complete range of the parameters, A and B. The integral $K(c, ab) = 1/\pi \int r_c^{-1} \exp(-r_a-r_b)d\tau$ is tabulated for many configurations of the three electrons or nuclei: a, b, and c. Numerical tables are given of all of the integrals cocurring in the Sugiura treatment of the ground state of H_2. The values of all of the other integrals used in the calculation of the energy of H_3 and of H_3^+ are given. It is expected that these tables will be useful for many problems of molecular quantum mechanics. AUTHOR.

13. Simple Formula for Calculation of Atomic Weights from Mass Numbers and Packing Effects. S. Meyer. *Akad. Wiss. Wien, Ber.* 147. 2a. 5–6. *pp.* 249–260, 1938.—Let M be the mass number, A the atomic weight in chemical measure, and Δ the total mass defect in the formation of the chemical element, then with H as unity for basis, it is found that, $\Delta = M - A/1\cdot00813$, when the single atomic weight 1·00813 is assigned to the isotope H. Further if Z be the ordinal number equal to the proton number, and $I = M - 2Z$ be the excess of neutrons with respect to protons in the atomic nucleus, then the simple formula follows, viz.—$\Delta = 0\cdot009\,(M - 1) - 0\cdot00013\,I^2$. From this formula the atomic weight A in the chemical mass system, with reference to the mixed element $0 = 16$, becomes $A = (M - \Delta) \times 1\cdot00785_3$. Agreement with the experimentally found chemical values is very satisfactory. For elements of small atomic weight up to *ca* 20, entry of a neutron into the nucleus contributes less to the mass defect than increase by a proton. H. H. Ho.

14. Calculation of Nuclear Distances, Separation Energies, and Atomic Refraction. E. L. Lederer. *Acta Physica Polonica*, 7. 2. *pp.* 110–124, 1938. *In German.*—The validity of the formulæ $(r_m-r_A)/r_A=1/(1+2^{m-1})$, and $E_{1,2} = 2q_D\,(r_{m_1}-r_{m_2})/r_A$ (where r_m is the nuclear distance for m-fold bonding, r_A is the atomic radius, q_D is the work of separation of the single bond up to the vapour state, and $E_{1,2}$ is the work of separation of the bond m_A to the bond m_2) has been established within the limits of error for all measurements hitherto undertaken, in so far as they did not concern excited or ionised atoms and were not influenced by neighbouring groups. The atomic radius is here defined as that distance up to which another nucleus can be brought with its middle point at an imaginary infinite bond. For the nuclear distances of ions in the crystal lattice, *e.g.*, of halides and certain oxides, correct values were obtained when the limits between chemical and physical influence ($m = 0$) were accepted as the bond. Further, in simple cases, statements can be made, with respect to the constitution of non-polar compounds and their stabilities, while a simple connection can be derived between the nuclear distances and atomic refractions (cf. Eisenlohr-Auwers) and also in connection with the so-called Abbe number. H. H. Ho.

15. Fourier Analysis of Interferometric Measurements of Free Molecules. P. Debye and M. H. Pirenne. *Ann. d. Physik.* 33. 7. *pp.* 617–629, *Dec.*, 1938.—The present paper contains a comprehensive theoretical discussion of Pauling and Brockway's method [see Abstract 1344 (1936)] for the direct determination of atomic distances in molecules. The original authors had derived by Fourier analysis a function $D(r)$

from the angular distribution of experimentally measured intensities, which should have maxima for those values of *r* which are equal to the different distances from nucleus to nucleus in the molecule. This method has given results in satisfactory agreement with the older data, and is now mathematically treated as a typical interference problem. H. H. Ho.

See also Abstracts 63, 115, 137, 203, 280, 325, 335, 360, 381, 397, 399.

COLLOIDS.

16. Ferromagnetic Ferric Oxide Aerosols and Hydrosols. A. Winkel and R. Haul. *Zeits. f. Elektrochem.* 44. *pp.* 823–831, *Nov.*, 1938.—The thermal decomposition of $Fe(CO)_5$ in a stream of N_2 containing a sufficiency of O_2 led, under favourable conditions, to the formation of aerosols of the ferromagnetic Fe_2O_3. If the decomposition of the iron carbonyl were carried out at 900° C. the γFe_2O_3 exhibited sharp X-ray interference, which was strongly widened as the temperature of the reaction was lowered. At 200° C. the product was practically amorphous to X-rays, and the magnetic susceptibility was of the order of magnitude corresponding to the paramagnetic αFe_2O_3. The partial pressure of O_2 influenced the progress of the decomposition of the carbonyl so as to indicate that the γFe_2O_3 was formed by the oxidation of the first formed iron aerosol with Fe_3O_4 as an intermediate step. Colloidal solutions of ferromagnetic Fe_2O_3 were obtained by peptisation of aerosol sediments, prepared by precipitation of aerosol sediments with water. F. J. B.

17. Particle Concentration in Colloidal Solutions from the Viscosity and Optical Density. A. Boutaric. *Comptes Rendus,* 207. *pp.* 802–804, *Nov.* 2, 1938.—By a combination of Rayleigh's equation for the optical density, and Arrhenius' equation for the viscosity, of a colloidal solution, the author deduces the relationship $(1/h)\log_e(\eta/\eta_o) = aN/bm$, where h = optical density of the suspension, η = viscosity of the suspension, η_o = viscosity of the dispersing medium, N = number of particles per unit volume, m = total mass of the particles in unit volume, and a and b are constants. This equation is applicable to concentrated suspensions. W. H. Wal.

18. Spectrophotometric Study of Slow Hydrolysis of Ferric Salts. J. Cathala and J. Cluzel. *Comptes Rendus,* 207. *pp.* 781–783, *Nov.* 2, 1938.—The variation with time of the colours of $N/100$ solutions of $Fe(NO_3)_3$ at constant temperature and for various pH values between 5 and 6 is studied spectrophotometrically. The results show that the absorbing substance does not change with time; but the rate at which its final concentration is attained increases rapidly with pH. The curves show a marked resemblance to those obtained from conductivity measurements. The nature of the coloured compound is not elucidated.

C. B. A.

19. Lattice Extension of Hydrated Cellulose by Combination With Absorbed Water. I. Sakurada and K. Hutino. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers No.* 832. *pp.* 1164–1173, *Oct.*, 1938. *In German.*—It is shown that, by X-ray investigations, the lattice of air-dried hydrated cellulose exhibits a small variation when quickly dried. Subsequent imbibition of water by the quickly dried hydrated cellulose restores the original diagram of ordinarily air dried material. The lattice alteration by sharp drying is therefore reversible. The lattice constants of quickly dried hydrated cellulose correspond with those found by R. Andress whilst the air-dried ordinary material constants are those stated by K. H. Meyer and H. Mark. By absorptive combination of water the 101 plane of the hydrated cellulose is broadened by 0·3 Å and the volume of the elementary body increases by 4%. Other planes than 101 exhibit no alteration whatever. S. G. B.

20. Viscosity of Petroleum Emulsions. L. T. Monson. *Indust. and Engin. Chem.* 30. *pp.* 1287–1291, *Nov.*, 1938.—Viscosity ratios (emulsion viscosity relative to clean oil viscosity) were determined for 20 water-in-oil emulsions prepared from 5 California crude oils, using 4 different phase-volume ratios at 3 temperatures. Details of the preparation and testing of the emulsions are given. The applicability of viscosity ratio as a general index of emulsion stability is discussed. AUTHOR.

21. Layer-Thickness in Plastic Vaseline-Mica Suspensions. M. P. Wolarowitsch and J. S. Jerochin. *Acta Physicochimica*, 9. 1. *pp.* 89–92, 1938. *In German.*—The constant θ, in Bingham's equation of plastic flow, was determined for a series of suspensions of powdered mica in vaseline containing 20–40% by weight of mica, by Wolarowitsch's rotating cylinder method. It was found that, on commencing the rotation, the resistance decreased and finally reached a constant value as the mica flakes became arranged in co-axial, cylindrical layers. The thickness, l, of the layers of vaseline thus formed was calculated from the known dimensions of the mica particles and their concentration. The value of θ was measurable for $l \gtreqqless 5$–6μ and increased rapidly for values of $l < 2$–3μ. These values of l are about 10 times greater than the corresponding values found directly by Derjaguin and others in their investigations of the anomalous elasticity of thin films of water. W. H. Wal.

22. Kataphoresis of Gas Bubbles. N. Bach and A. Gilman. *Acta Physicochimica*, 9. 1. *pp.* 1–38, 1938. *In English.*—A method for determining the true kataphoretic velocity of gas bubbles, taking into account the electroosmotic flow of H_2O in the cell is described. The method depends on the empirical determination of a coefficient characteristic of the propagation of the H_2O motion from the walls to the middle of the cell. This coefficient is independent of the nature of the disperse system. The experiments were carried out with emulsions of CCl_4–C_6H_6 mixtures in H_2O, and with suspensions of glass powder in very dilute KCl and $ThCl_4$. The method is then used with capillary-active organic electrolytes, *e.g.*, $N(C_4H_9)_4Cl$ and sodium palmitate. The charge on gas bubbles in the latter is negative and increases with increasing concentration, whilst the ζ-potential at the liquid-glass interface also increases. In the tetra-substituted NH_4 salts the charge is positive and there is no effect on the ζ-potential at the liquid-glass interface. A. J. M.

23. Kataphoresis of Gas Bubbles. A. Klemm. *Phys. Zeits.* 39. *pp.* 783–793, *Nov.* 15, 1938.—The theory of the kataphoresis of solid spherical particles is extended to include spheres of any viscosity. A value is deduced for the velocity of kataphoresis of gas bubbles, more especially in water, and the theoretical results are compared (satisfactorily) with Alty's experimental results [see Abstract 242 (1925)] and are used to discuss the synthesis of the gas-water interface. J. S. G. T.

24. Isoelectric Point of Charcoal. H. L. Bennister and A. King. *Chem. Soc., J. pp.* 1888–1891, *Nov.*, 1938.—The kataphoretic migration velocities of charcoals activated in moist O_2 at different temperatures and suspended in solutions of HCl and of NaOH of various pH have been measured by means of the ultramicroscope method. It is found that in these solutions all the charcoals are isoelectric between pH 3·0 and 4·0, and that there is an approach to a second isoelectric point in the neighbourhood of pH 1·0–1·5. The effect of the temperature of activation is marked in solutions of pH greater than 4·0, those activated at 850° having a maximum negative velocity. All the charcoals examined were negatively charged in all solutions of pH 4·0 and above. AUTHORS.

25. Effect of Salts on Electrophoretic Mobility of Tristearin. D. I. Breese and W. C. M. Lewis. *Faraday Soc., Trans.* 34. *pp.* 1515–1518, *Dec.*, 1938.—The electrophoretic mobilities of dispersions of purified tristearin in the presence of the chlorides, iodides and thiocyanates of K and Li respectively have been determined at constant H ion activity (pH = 4) at 25° C. With increase in concentration of electrolyte the normal behaviour is a fall in the mobility. It is shown that a limiting value for the mobility is exhibited by chlorides of the alkali metals, a slight lyotropic-series effect being detectable. The magnitude of the limiting value of the mobility is shown to be a function of pH. In the presence of iodides and thiocyanates the mobility at first falls, passes through a flat minimum, and thereafter steadily rises with increase in concentration of the electrolyte. This increase in mobility which occurs in the region of relatively high concentration is to be distinguished from the long familiar initial rise in mobility exhibited at very low concentrations of univalent electrolytes. The effect referred to above is ascribed to primary adsorption of iodide and thiocyanate ions upon the tristearin. This conclusion receives some support from the capillary behaviour of these ions at a liquid hydrocarbon-water interface. AUTHORS.

26. Coagulation of Sols by Electrolytes. Wo. Ostwald. *J. Phys. Chem,* 42. *pp.* 981–1000, *Nov.*, 1938.—After discussing the inadequacy of previous theories, the author proposes a new method of approach to the question of electrolyte coagulation of sols. According to the new theory, the properties of the dispersion medium should be considered rather than those of the disperse phase, the coagulating forces being identified with the interionic attraction forces between ions of the dispersion medium, as measured by the coefficient of activity, f, of the solution. The coefficient of activity referring to one ion type, can, according to the physical theory for water at 18° C., be defined as $-\log f^+ = 0 \cdot 5 z_+{}^2 \sqrt{u}$, where z represents the valency and u the ionic strength. $u = 1/2(m_+ z_+^2 + m_- z_-^2)$, where m_+ = molality of the kation, z_+ the valency of the kation, m_- the molality of the anion, and z_- the valency of the anion. A new formulation of the Schulze-Hardy valence rule is obtained, the molecular flocculating power ($= 1/m_k$, where m_k = flocculating molality) being given by $1/m_k = (z_+^5 (z_+ + z_-))/2K$. The anomalous coagulation powers of mixtures of two salts may be accounted for on the basis of the new theory, the theoretical values being in full accord with experiment. For solvents other than water at 18° C., an extended equation for f^+ must be used, which is a multi-function of the dielectric constant and temperature. The theory indicates that m_k must decrease with increasing temperature, and also with increasing addition of a solvent of lower dielectric constant, *e.g.*, alcohol. Quantitative agreement with experiment is obtained. W. H. Wal.

***27. Opaque Ultracentrifuges for Direct Analysis. J. W. McBain.** *J. Phys. Chem.* 42. *pp.* 1063–1069, *Nov.*, 1938.—A number of simple and very inexpensive opaque rotors are now available with which measurements both of sedimentation equilibrium and of sedimentation velocity have been made with an accuracy at least as great as that obtainable with the best transparent ultracentrifuges. AUTHOR.

***28. Design and Operation of Oil-Turbine Ultracentrifuge. G. Boestad, K. O. Pedersen and T. Svedberg.** *Rev. Sci. Instruments*, **9.** *pp.* **346–353,** *Nov.*, **1938.**—The development of the oil-turbine ultracentrifuge, from the first model built in 1925 to the latest, is traced, with special attention being given to the principles of design for maximum resolving power in the analysis of mixtures as the lowest expenditure of energy. The efficiency of various types of rotors combined with centrifugal or screw-type oil pumps is reported. By proper attention to design, it has been possible to attain an efficiency at 60,000 r.p.m. of 40% in the oil-turbines and an over-all efficiency of electric motor, oil pump, and oil turbines of 28%. The actual power consumption under these conditions is slightly over 1 kW, which appears to be somewhat better than has so far been attained with the air-turbine ultracentrifuge of comparable design. The frictional resistance of the rotor rotating in H_2 at 20 mm. pressure is 300 W, 32 W representing gas friction. The cost of electricity, cooling water and H_2 for operating the latest rotor and assembly at 60,000 r.p.m. exclusive of the vacuum system and recording instruments, is 9c. per hour, with electric power at 1·54c. kW-hr., water at 6·4c./m^3., and H_2 at 64c./m^3. The corresponding cost for an early model rotor and assembly was 28·7c. per hour. AUTHORS.

See also Abstracts 123, 134, 193, 366.

CRYSTAL STRUCTURE AND SPECIAL PROPERTIES.

29. Lattice Vibrations in Polar Crystals. R. H. Lyddane and K. F. Herzfeld. *Phys. Rev.* **54.** *pp.* **846–861,** *Nov.*, **1938.**—This paper investigates the free vibrations of a polar crystal of the NaCl type. The main purpose is the calculation of the Coulomb force, which has been done by an extension of the Madelung method. For numerical evaluation, a short range repulsion is assumed, and the van der Waals forces are neglected. The results are: For long waves one finds in the acoustical branch three waves whose frequencies are inversely proportional to the wave-length, in agreement with Born. The optical branch has two transverse waves (*Reststrahlen*) with a Coulomb force of $4\pi/3$ times the polarisation, as Born has calculated, and one longitudinal one with a Coulomb force of $-8\pi/3$ times the polarisation. For short waves the vibrations are in general not exactly transverse or longitudinal, but even in the optical branch there remain separate modes of vibration with different frequencies for a given wave-length. In addition, the neutral simple cubic lattice is considered. It is shown that the free vibrations are characterised by $D = 0$. The influence of the shape of the crystal is discussed. AUTHORS.

30. Effect of Reheating Al-Mg Solid Solution. P. Lacombe and G. Chaudron. *Comptes Rendus*, **207.** *pp.* **860–862,** *Nov.* **7, 1938.**—The changes in the parameter *a* in Al-Mg alloys containing 13·5–9% Mg, carefully homogenised by annealing for 24 hr. at 445°, resulting from reheating at 200° for various times up to 4 hr. were examined and are shown by curves in which for each alloy *a* is plotted against time of heating. With 13·5 and 12% Mg *a* at first increases to a small maximum and then decreases, the change with the greater percentage of Mg being more marked; with 11% Mg a similar but much smaller change occurred, and with 9% none at all. It is suggested that the changes are due to migration of Mg atoms to an ordered arrangement preliminary to precipitation, which occurs the more readily the greater the percentage of Mg. C. A. S.

31. Diffraction of X-Rays by an Age-Hardening Cu-Al Alloy. G. D. Preston. *Phil. Mag.* **26.** *pp.* 855–871, *Nov.*, **1938.** *Supplement.*—A single crystal wire with 110 plane parallel to the X-ray beam is mounted in an Al holder in the goniometer head of the spectrograph, removed, heated at 500° C. to bring the Cu into solution, replaced and photographed immediately, after 4 hr., 24 hr. and 16 days, at room-temperature. Changes which take place during the 1½ hr. exposure are naturally included. The author concludes that in a 4% Cu alloy the regions in which Cu segregation occurs are thin plates involving 5 or fewer (110) planes, the area being estimated at not more than 100 atomic diameters at room-temperature, and much less in the earliest stages of ageing. After heat-treatment at 200° C., hardness diminishes and the effects of the Cu-rich material disappear from the plates—apparently the Cu has gone back into solid solution. Further treatment increases hardness and the presence of thin Cu-rich plates of larger area is shown in the photographs; these are much thicker when maximum hardness has been attained, and eventually a second phase giving normal three-dimensional spots is formed. This is pseudo-CaF_2 in structure, being tetragonal with $a = 5 \cdot 71$ Å and $c/a = 1 \cdot 015$, the unit contains 4 Cu and 8 Al atoms, differing from the common $CuAl_2$, and may be either new or metastable. 100 planes of the Al lattice are in contact 001 planes in the new crystals, three of the latter being present in each Al crystal, one on each cube face. Analysis of a Laue photograph confirms the result from oscillating crystal photographs. [See also Abstract 4759 (1938).] D. R. H.

32. Pb-In System. S. Valentiner and A. Haberstroh. *Zeits. f. Physik*, 110. 11–12. *pp.* 727–741, 1938.—On the Pb side a substitutional solid solution is formed with decreasing lattice constant. In alloys with a Pb content exceeding about 30% (atomic), X-ray analysis by the powder method with rotating rods in cameras with $d = 5 \cdot 74$ cm., Cu radiation at 40 kV and 20 mA, and 2½ hr. exposure, showed precipitation at 172 C. of a tetragonal body-centred phase with 18 atomic % Pb ($In_{26}Pb_6$) with $a = 4 \cdot 87$ Å and $c/a = 0 \cdot 93$. This is capable of dissolving either In or Pb with alteration of a between 4·85 and 4·88 Å. If the Pb content exceeds about 20% (atomic) this phase is no longer stable at lower temperatures and dissociates at 159° C. to a phase containing 6·25% (atomic) Pb ($In_{30}Pb_2$) with $a = 4 \cdot 59$ and $c/a = 1 \cdot 08$ which can also dissolve Pb and In to some extent with slight alteration of lattice dimensions. For In, $a = 4 \cdot 59$ and $c/a = 1 \cdot 075$ in a face centred tetragonal (pseudo-cubic) lattice. For thermal observations the In-rich alloys were synthesised (5–15 gm.) in quartz tubes and later diluted with Pb, in view of the high cost of In. A Ni-chromel couple was used and the 172° point is found to occur in alloys with 19–41% (atomic) Pb, and the 159° C. point from 9 to 29% (atomic) Pb. Kurnakow's old work (see *Zeits. f. anorganische Chem.* 64. *p.* 149, 1909) is substantially confirmed. D. R. H.

33. Structure of $NaAu_2$. H. Perlitz and E. Aruja. *Zeits. f. Krist.* 100. 2. *pp.* 157–166, 1938.—Alloys containing 33·3% and 14·5% atomic. Au are synthesised from the two metals in an atmosphere of N_2 at 980° C. and water-quenched. Filings are sieved to pass a sieve of 100 wires/cm., gummed on a 0·05 mm. glass rod and examined by the powder method with Cu *K* radiation. $NaAu_2$ has the lattice of $MgCu_2$ (*C* 15) with 8 molecules in the unit cell, at 18·4° C. $a = 7 \cdot 7872 \pm 0 \cdot 0002_3$ Å.

X-ray density calculated from this is $11 \cdot 66$ against $11 \cdot 5_7$. In the quenched alloy with 14·5% Au a mean value of $7 \cdot 77_1$ Å for *a* was obtained, from which the limit of stability of the $NaAu_2$ lattice is put at 67⅔% Au. For Au at 20° C. $a = 4 \cdot 0700_1 \pm 0 \cdot 0000_8$ Å, in good agreement with previous values. [See Abstracts 1683 (1933) and 4455 (1935).] D. R. H.

34. Lattice Constant of Na. E. Aruja and H. Perlitz. *Zeits. f. Krist.* 100. 3. *pp.* 195–200, 1938.—The unit cell of Na is redetermined and is found to be cubic, $a = 4 \cdot 282_0 \pm 0 \cdot 000_5$ Å at 20° C., as the mean of six values; the density calculated from the X-ray data is $C = 0 \cdot 966_0$ $gm.cm^{-3}$. The estimated intensities of the reflections are in good agreement with the structure assigned to Na: a body-centred cubic lattice with two atoms in the unit cell. C. J. B. C.

35. Structure of Sodium Bromate. J. E. Hamilton. *Zeits. f. Krist.* 100. 2. *pp.* 104–110, 1938. *In English.*—$NaBrO_3$ was analysed by the single crystal oscillation photographic method, and the intensities of the reflections obtained accurately by using a microphotometer. The crystal belongs to the point group T-23 of the cubic system, space group $T^4 - P\,2_13$. There are 4 Na atoms in positions *uuu*, 4 Br atoms in positions *vvv*, 12 O atoms in positions *xyz*. The side of the unit cube is 6·71 Å. The parameter values were found by a two-dimensional Fourier analysis and are $u = 0 \cdot 075$, $v = 0 \cdot 405$, $x = 0 \cdot 258$, $y = 0 \cdot 614$, $z = 0 \cdot 480$. The inter-atomic distances are Na–O = 2·38 Å (coordination number 6), Br–O = 1·78 Å, O–O = 2·95 Å. The displacement, Δ, of Br from the plane of the O atoms = 0·53 Å, the bond angle, $\alpha = 111° 48'$. AUTHOR.

36. Structure of $PdCl_2$. A. F. Wells. *Zeits. f. Krist.* 100. 3. *pp.* 189–194, 1938. *In English.*—Palladous chloride crystallises in the rhombic system—space group *Pnmn* and cell dimensions: $a = 3 \cdot 81$ Å, $b = 3 \cdot 34$, $c = 11 \cdot 0$. There are 2 molecules in the unit cell—calculated density 4·20 $gm./cm^3$. The coordinates of the atoms are:—Pd($0\frac{1}{2}0$), ($\frac{1}{2}0\frac{1}{2}$); Cl($x0z$) etc., with $x = 0 \cdot 173$ and $z = 0 \cdot 132$. The structure is built up of infinite chains (along *b*) in which each Pd is surrounded by 4 Cl in a plane at a distance of 2·31 Å, and each Cl is attached to 2 Pd atoms, the chains being packed as in a rhombic long-chain hydrocarbon. AUTHOR.

37. Structure of NaCN. H. J. Verweel and J. M. Bijvoet. *Zeits. f. Krist.* 100. 3. *pp.* 201–207, 1938.—It is shown that the intensities of X-ray diffractions from the cubic modification of NaCN correspond to a C–N distance of 1·06 Å. On cooling below room-temperature the cubic crystal changes to a rhombic lattice in six orientations parallel to the CN group. After warming above the transformation temperature the cubic single crystal is re-formed in its original orientation. The unit cell of the low temperature modification has the dimensions $a = 3 \cdot 74$, $b = 4 \cdot 71$, and $c = 5 \cdot 61$ Å at about −10° C., with atomic positions, Na: 000; $\frac{1}{2}\frac{1}{2}\frac{1}{2}$, C and N: $\frac{1}{2}, \frac{1}{2} + u, 0$; $0, u, \frac{1}{2}$; $\frac{1}{2}, \frac{1}{2} - u, 0$; $0, \bar{u}, \frac{1}{2}$. The C–N distance in the low temperature form is 1·05 Å. A. G. Q.

38. Structure of NH_4HgCl_3. E. J. Harmsen. *Zeits. f. Krist.* 100. 3. *pp.* 208–211, 1938.—The unit cell of NH_4HgCl_3 is shown to be tetragonal with dimensions, $a = 4 \cdot 19 \pm 0 \cdot 02$ Å, $c = 7 \cdot 94 \pm 0 \cdot 03$ Å, and the atoms are in the positions, Hg: 0, 0, 0; Cl_1: $\frac{1}{2}, \frac{1}{2}, 0$; Cl_2: $0, 0, u$; $0, 0, \bar{u}$; NH_4: $\frac{1}{2}, \frac{1}{2}, \frac{1}{2}$, where Cl_1 and NH_4 may be interchanged. The value of u_{Cl_2} is 106°. It is shown that the model accounts for the observed (100) and (110) cleavages and also for the positive birefringence of the crystals. A. G. Q.

39. Structure of $K_2HgCl_4 \cdot H_2O$. C. H. MacGillavry, J. H. de Wilde and J. M. Bijvoet. *Zeits. f. Krist.* 100. 3. *pp.* 212–220, 1938. *In English.*—The crystal structure of $K_2HgCl_4 \cdot H_2O$ was determined. Cell dimensions $a = 8{,}27$, $b = 11{,}63$, $c = 8{,}89$ Å. Space group *Pbam*. Number of molecules per cell 4; X ray density 3·39. Atomic positions: 4 Hg on 4(*e*) with $z = 0{,}288$; 4 Cl on 4(*g*) with $x = 0{,}211$, $y = 0{,}072$; 4 Cl on 4(*h*) with $x = 0{,}228$, $y = 0{,}067$; 8 Cl on 8(*i*) with $x = 0{,}117$, $y = 0{,}189$, $z = 0{,}256$; 4 K on 4(*g*) with $x = 0{,}072$, $y = 0{,}342$; 4 K on 4(*h*) with $x = 0{,}106$, $y = 0{,}308$; 4 H_2O on 4(*f*) with z about $\frac{1}{4}$.

AUTHORS.

40. Lattice Limitation of Montmorillonite. S. Hendricks and C. S. Ross. *Zeits. f. Krist.* 100. 3. *pp.* 251–264, 1938. *In English.*—The question of lattice limitation of montmorillonite and related minerals is discussed in the light of electron and X-ray diffraction data and optical properties. Evidence obtained indicates that individual montmorillonite crystals contain many alumino-silicate layers and that these layers have a rather regular arrangement with respect to one another as long as a few orders of reflection from (001) can be observed. AUTHORS.

41. Structure of Bromostannates, A_2SnBr_6 ($A = Cs, Rb, NH_4, K$). G. Markstein and H. Nowotny. *Zeits. f. Krist.* 100. 3. *pp.* 265–271, 1938.—An X-ray analysis has been carried out for the compounds, Cs_2SnBr_6, Rb_2SnBr_6, $(NH_4)_2SnBr_6$ and K_2SnBr_6. The first three have face-centred cubic lattices with 4 mol. per unit cell and lattice parameters, $a = 10{\cdot}81 \pm 0{\cdot}02$, $10{\cdot}64 \pm 0{\cdot}02$, and $10{\cdot}59 \pm 0{\cdot}03$ Å respectively. The lattice of K_2SnBr_6 can be looked upon as a distorted cube similar to the above with $a = 10{\cdot}51 \pm 0{\cdot}02$ Å, but it is really tetragonal with $a = 7{\cdot}43 \pm 0{\cdot}01$, $c = 10{\cdot}61 \pm 0{\cdot}02$ Å, space group $= D^2_4$. The difference between the structure of K_2SnBr_6 and the other compounds is discussed and the effects of coordination and ion size are considered.

J. I.

42. Structure of $(NH_4)_3ZrF_7$ and K_3ZrF_7. G. C. Hampson and L. Pauling. *Am. Chem. Soc., J.* 60. *pp.* 2702–2707, *Nov.*, 1938.—X-ray photographs of ammonium heptafluozirconate indicate a Laue holohedral face-centred cubic unit of structure with $a_0 = 9{\cdot}365$ Å, containing 4 $(NH_4)_3ZrF_7$. The theory of space-groups provides no way of placing all of the atoms in definite positions in the unit. A structure involving some randomness of distribution among positions provided by the space group O^5_h is found to account satisfactorily for the X-ray data. This structure is closely related to that of $(NH_4)_3AlF_6$; the $[AlF_6]\equiv$ complex ions are replaced by $[ZrF_7]\equiv$ complex ions in which Zr has coordination number seven. K_3ZrF_7 is found to have a similar structure, with $a_0 = 8{\cdot}95$ Å.

AUTHORS.

43. General Graphical Method for Determining Spacings of Lattice Planes. M. A. Peacock. *Zeits. f. Krist.* 100. 2. *pp.* 93–103, 1938. *In English.*—The following theorem is proved: The spacing of a set of planes *hkl* in any lattice is equal to the vertical period of the lattice divided by the central distance of the point *hkl* in the reciprocal lattice whose horizontal layers have a spacing of unity. A convenient construction, using given or computed gnomonic projection elements, rapidly gives the central distance of any reciprocal lattice point *hkl*, from which the relative or absolute spacing of the corresponding set of lattice planes is immediately obtained. A device named the sphere of Bravais probability is introduced. This sphere contains the reciprocal lattice points of all the probable forms of a crystal species, according to an idealised form of the law of Bravais, and provides a means of determining the indices of all planes with spacings down to a chosen minimum. The procedures in the higher symmetries and for lattice centreing and space group conditions are outlined. A list of graphically determined spacings for axinite is given and briefly discussed. AUTHORS.

44. Reciprocal and Bravais Lattices of Gypsum. W. F. de Jong and J. Bouman. *Zeits. f. Krist.* 100. 3. *pp.* 275–276, 1938.—The reciprocal and Bravais lattices of gypsum given by Dana and Des Cloiseaux, Wooster and Bragg, are discussed and compared. On the basis of X-ray measurements a new reciprocal lattice is suggested which corresponds to absolute axial lengths: $a = 5\cdot63$, $b = 15\cdot15$ and $c = 6\cdot23$ Å, with $\beta = 113^\circ 50'$ and 4 mol. per cell. J. T.

*45. **Double-Crystal Spectrometer with Photographic Recording and Measurement of Imperfection of Crystals. J. Fejfer and M. Jahoda.** *Comptes Rendus*, 207. *pp.* 737–739, *Oct.* 24, 1938.—The differences from the more usual method are that the recording is photographic instead of by ionisation, and that the two crystals are fixed and in the antiparallel position. The arrangement is figured diagrammatically, and results with NaCl, ZnS and SiO_2 are given. They show constant minimum values for the imperfection, due in each case to a characteristic regular mosaic structure, but variable maximum values indicating a coarser structure. C. A. S.

46. Structure of Condensed Ring Compounds. Part VII. J. Iball. *Zeits. f. Krist.* 100. 3. *pp.* 234–241, 1938. *In English.*—The crystal structure of 3 : 4-benzphenanthrene and three of its derivatives have been investigated by means of X-rays. The crystal data are given. From a consideration of the crystal structure and the diamagnetic anisotropy it is concluded that the molecule of hexahydrobenzphenanthrene has a *cis*-configuration. [For Part VI see Abstract 3062 (1938).] AUTHOR.

47. Vitrification and Crystallisation of Organic Cells at Low Temperatures. A. Goetz and S. S. Goetz. *J. of Applied Physics*, 9. *pp.* 718–729, *Nov.*, 1938.—The author first discusses the theoretical conditions which determine whether a homogeneous liquid will solidify into a crystalline or into a vitreous state and gives an account of the role of the speed of crystallisation and of grain formation. The ideas developed are applied to the case of non-dehydrated organic cells. The experimental technique, criteria of death etc. used in a study of the effect of different conditions of cooling on the death rates of pure strains of yeast are described. It is found that the death rate at an exposure of − 185° C. varies from approximately 75% to approximately 3% when conditions favouring crystallisation are changed to those favouring vitrification. Duration of exposure at − 185° C. has no appreciable effect, nor has change of temperature between − 185° and − 252° C. but above − 150° C. the death rate is dependent on temperature and on time of exposure. The effect of repeated freezings is complicated by other effects. J. I.

48. Theory of Anisotropic Liquids. C. W. Oseen. *Arkiv f. Mat. Astron. och Fysik, Stockholm,* 26*A*. 5. [10 *pp.*]. 1938. *In French.*—The author derives partial differential equations for the determination of molecular orientations in an anisotropic liquid, which supplement his previous theory. Reciprocal effects between the molecules are now considered which were neglected in former analysis. The paper, which is entirely mathematical, treats the problem in the following sections: Rotation and fundamental hypotheses; derivation of the expression for potential energy; equations for the determination of the orientations of molecules; comparison with previous theories; an alternative form for the fundamental equation. H. H. Ho.

49. Scattering of Light by Anisotropic Liquids. Parts I and II. V. Zwetkoff. *Acta Physicochimica,* 9. 1. *pp.* 111–140, 1938. *In German.* —Part I deals with investigations in transmitted light. Measurements of transmission have been carried out with p-azoxyanisole in magnetic fields up to 22000 gauss, with special consideration of the influence of the surface layer upon the result. It was established that both in the longitudinal and also in the transverse magnetic fields of about 2000 gauss the transmission attained saturation, and thence remained unaltered in fields up to 22000 gauss. The degree of depolarisation which the light undergoes when passing through an anisotropic-liquid layer in longitudinal and transverse magnetic fields of different strengths has also been investigated. It is established that when the elliptical volume polarisation and the depolarising effect of the surface layer are excluded, then the depolarising effect decreases both in the longitudinal and transverse magnetic fields and practically disappears at about 2000–3000 gauss. Part II considers the depolarisation of the scattered light for the cases of acetoxybenzalazine and azoxyanisole. A higher degree of depolarisation was found for scattering in the isotropic phase. The scattered light is completely depolarised in the anisotropic phase. A magnetic field up to 20000 gauss exerts no influence on the degree of polarisation. It is concluded that the anisotropic substance is microscopically homogeneous in magnetic fields exceeding 20000 gauss. The scattering of light is opined to be a consequence of thermal oscillations of molecular groups whose magnitudes are comparable with wave-lengths. H. H. Ho.

50. Growth of Alkali Halide Crystals. H. Morgenstern. *Zeits. f. Krist.* 100. 3. *pp.* 221–227, 1938.—Experiments on the growth of crystals of LiF, NaCl, KCl, KBr and KI were made by growing spheres of the salts in aqueous solution. The spheres were obtained by grinding round a crystalline mass of the salt obtained by the fusion and cooling of it in a Pt crucible: the crystallisation was carried out in a thermostat constant to 0·005° C. LiF was found to crystallise as a powder all over the sphere. NaCl produces the faces {110}, {210}, {111} and {100} with the {100} as the final form, although the combination {100}, {111} and {210} is a very stable one. On KCl the faces {111} and {100} appear, but the final form is {111}. With KBr the form {111} never appears, {100} being the only form appearing. KI behaves very similarly to KCl. G. G.

51. Regular Growth of p : p′-Dioxydiphenyl on Calcite and Sodium Nitrate. J. Willems. *Zeits. f. Krist.* 100. 3. *pp.* 272–274, 1938.—When a solution of *p : p′*-dioxydiphenyl in an organic solvent is allowed to evaporate on glass it is deposited in an apparently amorphous state. However if the solution evaporates on the rhombohedral face of a calcite crystal, small crystallites of elliptic cross-section are formed. These have their long axes parallel to the long diagonal of the rhombus, and frequently have other crystallites at right angles to them forming a cross. Similar results are obtained on $NaNO_3$ crystals. J. I.

52. Crystal Growth. D. Balarew and N. Kolarow. *Zeits. f. Krist.* 100. 2. *pp.* 167–170, 1938.—Experiments are described in which the solubilities of old and of fresh gypsum crystals are compared under definite conditions of temperature, etc. Differences are observed in the solubility curves of old crystals, depending on whether the standard temperature (23° C.) is approached from below or from above whereas no such differences are observed with sufficiently fresh crystals. In addition, the speed of attaining equilibrium is many times greater in the case of fresh crystals as compared with old ones. These results are related to the authors' earlier work on the theory of crystal growth. J. I.

53. Formation of Crystallisation Nuclei. C. Hammer. *Ann. d. Physik*, 33. 5. *pp.* 445–458, *Nov.*, 1938.—The theories of the formation of crystallisation nuclei are discussed and experiments are described in which the author investigates the effect of various conditions on the number of crystallisation nuclei in piperonal. In an undercooled liquid the number of nuclei attains, in a very few minutes, a limiting value which is dependent on the degree of undercooling. In the case of a melting bath the relations of nuclei number to temperature and to time can be expressed by simple formulæ. Electrophoresis experiments are carried out on ultra-nuclei under various conditions, and in addition on the general effect of an electric field on nucleus formation. J. I.

54. Velocity of Crystallisation of Pb Containing Small Amounts of Ca, Sr, Ba and Ag. E. Jenckel. *Zeits. f. Metallkunde*, 30. *pp.* 396–399, *Nov.*, 1938.—The velocity of crystallisation of pure Pb increases with increasing supercooling, reaches a maximum and then rises at a very rapid rate. The number of crystallites increases correspondingly; those from Pb melted *in vacuo* are more uniform than those from Pb melted in air. The effect of small additions of the alkaline earth metals and of Ag is then described in detail. [See also Abstract 1007 (1937).]
H. J. H. S.

55. Optical Studies on Stovaine and Three Related Compounds. B. Campbell and M. L. Willard. *Zeits. f. Krist.* 100. 2. *pp.* 111–119, 1938. *In English.*—The following data are given for the benzoate ester hydrochlorides of (i) dimethylamino-methyl-methyl-ethylcarbinol (stovaine), (ii) diethylamino-tertiary-butylalcohol, (iii) β-dimethylamino-ethyl-dimethyl-carbinol, (iv) γ-dimethylamino-propyl-dimethyl-carbinol: (i) monoclinic prisms and rectangular plates; $2v = 34° 24'$; $\alpha = 1{\cdot}525$, $\beta = 1{\cdot}620$, $\gamma = 1{\cdot}630$; (ii) monoclinic prisms, $2v = 52° 40'$; $\alpha = 1{\cdot}504$, $\beta = 1{\cdot}605$, $\gamma = 1{\cdot}635$: (iii) monoclinic prisms and rectangles, $2v = 7° 10'$; $\alpha = 1{\cdot}520$; $\beta = 1{\cdot}595$, $\gamma = 1{\cdot}597$; (iv) monoclinic prisms, $2v = 88°$ (calc.); $\alpha = 1{\cdot}524$, $\beta = 1{\cdot}543$, $\gamma = 1{\cdot}572$. Diagrams are given showing the relation of the extinction directions to the shape of the crystals. J. I.

56. Optical Crystallographic Studies with the Polarising Microscope. Part II. W. M. D. Bryant and J. Mitchell, Jr. *Am. Chem. Soc., J.* 60. *pp.* 2748–2751, *Nov.*, 1938.—Optical crystallographic data and melting points of the *p*-bromoanilides of nine lower aliphatic acids have been determined. Metastable crystalline modifications of the *n*-valeric, isovaleric, *d,l*-methylethylacetic, and methacrylic derivatives have been obtained from the molten material. The unsaturated methacrylic derivative was successfully prepared by the regular procedure, without formation of the chloroisobutyric derivative. [For Part I see Abstract 3063 (1938).] AUTHORS.

57. Water of Crystallisation of Gypsum. J. Cabannes. *Comptes Rendus*, 207. *pp.* 700–702, *Oct.* 24, 1938.—The valency oscillations characteristic of the H_2O molecule, *i.e.*, ν_a (symmetrical) = 3650, and ν_b (antisymmetrical) = 3750 cm^{-1}., are found in gypsum crystals at 3404 and 3495 cm^{-1}. respectively. This diminution of approximately 250 cm^{-1}. is due to the action of the O and Ca ions to which the water molecule is bound. W. R. A.

58. Magnetic Anisotropy and Structure of $CuSO_4 \cdot 5H_2O$. Part III. K. S. Krishnan and A. Mookherji. *Phys. Rev.* 54. *pp.* 841–845, *Nov.* 15, 1938.—Measurements have been made of the magnetic anisotropy of $CuSO_4 \cdot 5H_2O$ at different temperatures from 26° C. to −190° C. The crystal is nearly uniaxial magnetically, and its two principal susceptibilities conform roughly to the Curie law, with different Curie constants. The observed anisotropy of the crystal may be attributed to the anisotropy induced in the Cu^{++} ion under the influence of the asymmetric electric field of the neighbouring negatively charged atoms. From the known positions of these atoms the field should be expected to have tetragonal symmetry. The two principal susceptibilities of the Cu^{++} ion, along the tetragonal axis of the field, and perpendicular to the axis, respectively, are calculated. The corresponding effective magneton numbers are calculated therefrom, and it is found (1) that these magneton numbers vary little with temperature, and (2) that the magneton numbers corresponding to the two principal susceptibilities of the ion are widely different. [For Part II see Abstract 4311 (1938).] AUTHORS.

59. Intensity of Points in a Reciprocal Lattice Projection. J. Bouman and W. F. de Jong. *Physica*, 5. *pp.* 817–832, *Oct.*, 1938. *In German.*—In earlier papers [see Abstract 1800 (1938)] the authors have described a method of taking X-ray rotation photographs in such a way that the photograph is a reproduction of the projection of the reciprocal lattice of the crystal. In the present paper they derive formulæ for the intensities of the points of the reciprocal lattice projection so obtained, and discuss the necessary corrections for extinction, etc. A photograph of the apparatus is given and examples of the lattice projections obtained with it are illustrated. J. I.

See also Abstracts 19, 73, 89, 114, 130, 135, 136, 152, 254, 321, 332, 344, 383, 443, 445 and

12B. Ternary System of Al. Part I. H. Hanemann and A. Schrader.

DENSITY.

60. Apparent Molal Volume of Urea. F. T. Gucker, Jr., F. W. Gage and C. E. Moser. *Am. Chem. Soc., J.* 60. *pp.* 2582–2587, *Nov.*, 1938.—Using a differential pyknometer method, the densities of aqueous solutions of urea from 0·1 to 4 molar at 30° and from 0·1 to 9·5 molar at 25° have been measured. The apparent molal volume of urea is a linear function of the volume concentration, *c*, over the whole range at 30° and up to 3 molar at 25°. Urea therefore behaves like sucrose and not like typical electrolytes, the apparent molal volumes of which increase linearly with $c^{1/2}$. The experimental results and the partial molal volumes of urea and water are tabulated. Equations giving the apparent molal volume and density as functions of concentration are also included. The density of solid urea is found to be 1·329 gm./ml. at 25° and its molal volume 45·19 ml. AUTHORS.

61. Specific Gravities of Pure and Mixed Salt Solutions. R. W. Bremner, T. G. Thompson and C. L. Utterback. *Am. Chem. Soc., J.* 60. *pp.* 2616–2618, *Nov.*, 1938.—The specific gravities of various solutions of salts occurring in sea water have been measured at 5° intervals from 0 to 25° inclusive. The solutions were prepared to contain the pure and mixed salts in concentrations covering the range found in nature. The specific gravity measurements, which are accurate to five decimal places and closely estimated to the sixth, were made by the method of weighing a weighted glass bulb suspended in the solution. Some of the data on the specific gravity of NaCl solutions reported to five decimal places in the "International Critical Tables" can be represented by the equation proposed by Root to only four decimal places. Certain more accurate data on KCl solutions have been shown to be entirely consistent with the data reported in this paper. The equation proposed by Root has been shown to reproduce the experimental results, within the limits of experimental error, at each of the six temperatures used. It applies equally well to solutions containing one solute and to those containing NaCl + KCl and NaCl + $MgSO_4$. The constants for this equation have been calculated at six temperatures for each of the five types of solutions studied. AUTHORS.

62. Densities of Fine Powders. Part II. J. L. Culbertson and M. K. Weber. *Am. Chem. Soc., J.* 60. *pp.* 2695–2697, *Nov.*, 1938.—Density measurements of silica and charcoal, using a series of liquids as the buoying fluid, indicate that polar liquids yield high density values for silica, non-polar yield low values. The more compressible liquids yield the higher density values for charcoal. Polar liquids having large compression coefficients yield high density values for both sides. Density measurements of ground quartz of varying degrees of fineness were made by means of benzene and water as the buoying fluids. These measurements confirm the foregoing statements and indicate that a different degree of penetration of different liquids into the surface of the solid is probably not a factor of significance in the variations of apparent density. [For Part I see Abstract 1481 (1937).] AUTHORS.

See also Abstract 338.

DIFFUSION AND OSMOSIS.

63. Molecular Size by Dialysis. W. Nowatke. *Acad. Polonaise Sci. et Lettres, Bull.* 3–5*A. pp.* 218–231, *March–May*, 1938. *In German.*—The author reviews methods for the determination of the molecular constants of a solute by diffusion measurements. Since the dialysis constant, δ, has been found to be proportional to the diffusion constant, K, the following relationships are deduced; $\delta\sqrt{M}$ = const., $\delta\sqrt{n}$ = const., δr = const., where M = molecular weight of the solute, n = number of atoms per molecule, and r = molecular radius. Experimental results to illustrate the validity of these relationships are given. W. H. WAL.

ELASTICITY AND PLASTICITY.

64. Deformation of a Tube Half-Full of Water. A. Anzelius and O. H. Faxén. *Arkiv f. Mat. Astron. och Fysik, Stockholm,* 26*A.* 7. [25 *pp.*], 1938. *In German.*—The problem of a tube of finite length, built in at the ends, and half-full of water, is solved in two stages. In the first the tube, half full, is imagined to be just immersed in a fluid of density 0·5, while in the second the tube is imagined to be surrounded by air and filled with fluid of density 0·5. W. G. B.

65. Torsion of Bar under Tension. P. M. Riz and N. V. Zvolinsky. *Comptes Rendus (Doklady) de l'Acad. des Sciences, U.S.S.R.* 20. 2–3. *pp.* 101–104, 1938. *In English.*—According to the linear theory of elasticity, the state of stress of a prism subjected to combined torsion and tension is obtained by superposing the two sets of stresses for torsion and tension acting separately, and this result does not accord with experiment. In this paper, second-order terms are retained in the expression for the strains, and the law relating principal stresses σ_i with principal elongations e_i is assumed to be, for finite displacements not exceeding the limit of proportionality, $\sigma_i = \lambda \sum_{a=1}^{3} e_a + 2Ge_i$. An expression is then worked out for the torsional stiffness T of the prism, which provides a correcting factor to T_0, the stiffness in the absence of tension. J. P. A.

66. Method of Solving Torsion and Bending Problems of a Bar with Axial Holes. S. Negoro. *Tohoko Univ., Sci. Reports*, 12. 4. *pp.* 17–28, 1938. *In English.*—The torsion or flexure function for such a bar can be found as sum of appropriate multiples of functions satisfying boundary conditions, each function being specially related to the boundary of one particular hole. These functions can be determined either experimentally (by the soap film, or some other, analogy), or by a numerical process. To render the displacement single-valued, certain integrals taken round contours including one or more holes must vanish, which fact leads to sufficient equations to determine the constants of the general solution. It is suggested that it is convenient to take these contours as rectangles, or that their boundaries should be composed of segments parallel to either the $x-$ or the $y-$ axis. W. G. B.

67. Thermal Dependence of Elasticity in Solids. L. Brillouin. *Phys. Rev.* 54. *pp.* 916–917, *Dec.* 1, 1938.—A theoretical study suggests a distinction between the elasticity coefficients for very high frequencies (of the elastic waves representing thermal agitation) and for low frequencies. These last coefficients should show a rapid decrease of rigidity when temperature increases, and the melting point can be said to represent the point at which the macroscopic rigidity becomes zero. AUTHOR.

***68. Electrostatic Method of Measuring Elastic Constants. D. Bancroft and R. B. Jacobs.** *Rev. Sci. Instruments*, 9. *pp.* 279–281, *Sept.*, 1938.—An apparatus is described for determining the elastic constants by vibrating specimens and determining the resonant frequency. Use is made of electrostatic means both for drive and pick-up to avoid the temperature limitations of the more usually convenient magnetic or piezoelectric methods. To avoid the insensitiveness of this electrostatic method, the damping is reduced to a minimum by supporting the specimen which is in the form of a rod 4″ long and 0·25″ dia. at three points on a nodal section. The driving and pick-up electrodes are insulated plates arranged so that the air gaps between these and the vibrating surfaces of the specimen are about 0·001″. The pick-up electrode is connected directly to the grid of an R.C.A. 1603 valve, with load in the kathode circuit so as to reduce the input capacity rather than provide amplification. A low pass filter is inserted between this valve and the remaining amplifier to reduce unwanted noise. A special form of fin electrode mounted in a diametrical slot in the ends of the specimen permits torsional measurements to be made. By the device of doubling the mass of the fins and observing the effect on the resonant frequency the allowance to be made for the loading of the fins can be determined. The whole apparatus including the first valve is mounted in a gas-tight tube and so arranged that it may be immersed in various temperature baths. Results for a carefully annealed carbon steel specimen give values of $20{\cdot}61 \times 10^{11}$ dynes/cm². for Young's modulus and $8{\cdot}080 \times 10^{11}$ dynes/cm². for the rigidity. F. S. B.

69. Elastic Constants of Transparent Solids. C. Schaefer and L. Bergmann. *Zeits. f. Physik,* 110. 11–12. *pp.* 763–764, 1938.—In contradiction to the claim by Hoesch [see Abstract 3922 (1938)] to have described the first method of determining both elastic constants of transparent isotropic bodies, it is pointed out that the authors published some time ago their results obtained by diffraction of light by elastic waves. R. P.

70. Change of Elastic Limit of Al by Annealing. M. Sugihara. *Kyoto Coll. Sci., Mem.* 21. *pp.* 145–162, *Sept.,* 1938. *In English.*—A cold-worked Al rod was heated in an electric furnace, and then cooled suddenly to the room-temperature. The change of the elastic limit of such a rod was measured. The elastic limit decreases with the increase of the annealing temperature and the annealing time. The plastic elongation of an annealed Al rod and its elastic limit were measured repeatedly after a lapse of certain time intervals. It is observed that the elastic property is recovered, and after the lapse of a certain time its elastic limit becomes somewhat larger than the initial one. A cold-worked Al rod was annealed, elongated plastically beyond its elastic limit, and annealed again for various durations of time at various temperatures. The elastic limit of the rods thus obtained was examined. When the second annealing temperature is comparatively low, the elastic limit increases at the beginning of the annealing time, and in some cases reaches a maximum. This increase of the elastic limit by weak annealing is ascribed to the recovery of the spots of weak cohesion between atoms, which were formed by the previous plastic deformation. AUTHOR.

71. Elasticity of an Al Rod and its Crystal Grains. M. Sugihara. *Kyoto Coll. Sci., Mem.* 21. *pp.* 163–168, *Sept.,* 1938. *In English.*—Among the elastic properties of aluminium rods composed of crystal grains of various sizes, Young's modulus has the same value independent of the crystal sizes. The value is almost the same as that of the crystal itself. On the contrary the elastic limit represented by the elongation per unit length depends upon the crystal size. This seems to be due to the fact that the elastic limit at the inner part of the crystal is much affected by its boundary which is elastically stronger. The relation between the elastic limit and the grain number is expressed by a relatively simple formula. AUTHOR.

72. Rigidity Modulus of Ni and Ni-Alloys. D. H. Landon and R. M. Davies. *Phil. Mag.* 26. *pp.* 816–840, *Nov.,* 1938. *Supplement.*—Values of the rigidity modulus of Ni and of 7 Ni-alloys, *viz.,* Monel, Ferry, Glowray, Brightray, Dullray, 48% Ni-Fe alloy and 20% Ni-Ag alloy, in both the annealed and unannealed conditions were determined at room-temperature, by setting bars of the metal or alloys into forced torsional vibration and determining the frequency corresponding to maximum amplitude. Values of Young's modulus and Poisson's ratio are also tabulated for all the test-pieces. J. S. G. T.

73. Plastic Flow in Metals. *Roy. Soc., Proc.* 168*A. pp.* 302–317, *Nov.* 7, 1938.—A report of a discussion.

W. L. Bragg pointed out the weakness of a perfect crystal, and the steady state attained after severe cold work with random orientation of the crystal grains and characteristic mechanical properties. The different theories of plastic flow were admittedly incomplete and probably far too simple. How did the mosaic of small size (1–5 μ) confer hardness and could a quantitative theory be developed ?

C. H. Desch described phenomena showing that certain bands are more highly deformed than the remainder of the crystals. The direction of Lüders lines depends on that of the applied stress and their spacing is wide in comparison with slip bands.

G. I. Taylor dealt with the elastic and plastic strain energies associated with the movement of a boundary between two crystals of slghtly different orientation, and that of a plane of dislocations all of the same sign moving across a crystal. The geometry is identical in these two cases.

N. F. Mott dealt with resistance to glide in alloys on Taylor's theory.

E. Orowan discussed the rate of plastic flow as a function of temperature (by analogy with chemical reactions $V = Ce^{-\alpha/kt}$) under the heads of amorphous plasticity, crystalline plasticity, and creep.

E. N. da C. Andrade from Laue photographs of α-Fe, β-brass, W, Mo, Na, K, suggested that work-hardening is inevitably accompanied by crystal break-up and rotation of the fragments in the glide lamellæ. Near the m.pt. where little work-hardening occurs, there is little rotation, even at large deformation.

G. D. Preston discussed age-hardening and work-hardening in a high purity alloy of Al with 4% Cu [see Abstract 4759 (1938)]. The cold-working of Cu_3Au reduced it to disorder, but whether localised internal heating occurs or not, the effect is the same as quenching from 600°–700° C.

W. H. Hatfield dealt with brittle materials with high electrical conductivity and the $\gamma \rightarrow \alpha$ phase change on cold-working austenitic Ni-Cr-steel (staybrite). D. R. H.

74. Evaluation of Yield Value with Sphere Viscometer. J. C. Williams and E. I. Fulmer. *J. of Applied Physics,* 9. *pp.* 760–764, *Dec.,* 1938.—Various methods and formulæ for determining yield value have been critically reviewed and a method is proposed for determining the yield value by means of the sphere viscometer. AUTHORS.

75. Flexural Motion of an Elastic Rod Caused by a Blow. S. Higuchi and Z. Takabayasi. *Tohoku Univ., Technol. Reports,* 12. 4. *pp.* 1–11, 1938. *In English.*—The problem of the flexural vibration of a cantilever caused by a blow applied within some arbitrary range near its free end, is discussed. The main purpose of the investigation is to obtain a solution under the condition stated above and also to inquire closely into Rayleigh's solution in which the position where the blow is applied is assumed to be a very small portion. As is commonly known there is another popular solution of the subject obtained by considering the energy of the system. Though this solution explains entirely different phenomena from those which are governed by Rayleigh's, the authors have compared them by transforming Rayleigh's solution into similar form to the other. Remarks are added on the calculation of stress distribution in the cantilever at the time of impact. AUTHORS.

76. Damping of Lateral Vibration of Steel Bar. A. J. Ockleston. *Phil. Mag.* 26. *pp.* 705–712, *Nov.,* 1938.—In studying the internal friction of solids a common assumption, by analogy with viscous liquids, is that the internal frictional forces are proportional to the rate of change of the stresses. For a laterally vibrating rod this would give a logarithmic decrement proportional to frequency. Experiments by Kimball and Lovell showed that this law was not followed, and that for a laterally vibrating rod although the decay was logarithmic it was independent of frequency and equal to a constant × "E," the constant being termed the "internal frictional constant." This paper describes a series of tests carried out by the author on a steel bar 16″ by 1·5″ by 0·375″, carefully and rigidly clamped, the motion being observed by an optical system giving a photographic trace on a moving film. Contrary to both theories the decay of the vibrations of the rod was not logarithmic, but showed that the internal frictional constant decreases with decrease in amplitude. These results are borne out by Rowett who measured the relative widths of hysteresis loops for steel subject to cyclic shearing stresses. In all cases the loss of energy per cycle depends only on the stress amplitude and is independent of frequency, while only in the case of large stress amplitudes is the decay of lateral vibration approximately logarithmic according to the Kimball and Lovell law; for small stress amplitudes this law is not satisfactory. F. S. B.

77. Torsional Vibration in Certain Mechanical Systems. W. A. Tuplin. *Phil. Mag.* 26. *pp.* 729–752, *Nov.*, 1938. *Supplement.*—The systems dealt with are those consisting of rotors connected by torsionally elastic members, and their variants. The cases investigated mathematically are the simple geared system, the application of torque at the end of a straight-line system, the general case of epicyclic gear assembly, gears on a single carrier and branched and network systems, for which frequency equations are derived. G. E. A.

78. Stability of a Certain Subharmonic Oscillation. O. Bünemann. *Manchester Phil. Soc., Mem.* 82. *pp.* 67–78, 1937–1938.—If a system is excited by a simple harmonic force its equation of motion can be reduced to $\ddot{y} + n^2\dot{y} - Ay^3 = f \sin pt$ if there is negligible friction. For a certain amplitude, f, of the external force, a pure subharmonic $y = \mathrm{B} \sin \tfrac{1}{3}pt$ is formally a solution of the equation but the physical reality of this subharmonic solution depends on its stability. The stability of this oscillation is discussed with regard to (1) change of the initial conditions, and (2) change of the constants in the differential equation (stability in general, according to Liapounoff). R. S. R.

79. Angle of Fracture of Glass. J. Boow. *Soc. Glass Technol., J.* 22. *pp.* 261–267, *Oct.*, 1938.—The breaking strength values derived from tests on 400 standard size specimens, fire-polished by annealing, have been analysed with a view to investigating the relation between the strength and the type of fracture obtained It has been shown that, in the case of the **V**-type of fracture, about one-fifth of the variation in the values can be traced to variations in the angle of forking. The possibility of the whole of the variations being due to differences in the type of fracture is discussed. AUTHOR.

See also Abstract 21 and

9B. Fracture of Cast Iron. I. Iitaka and I. Yamagishi.
14B. Fatigue of Metals. Part I. Y. Kidani.
16B. Surges in Springs. K. J. DeJuhasz.
17B. Photoelasticity in Testing. P. Laurent and A. Popoff.

GRAVITATION.

See Abstract 113

HYDRODYNAMICS AND AERODYNAMICS.

80. Oscillatory Motion of a Viscous Liquid in a Circular Tube of Infinite Length. Z. Takabayasi. *Tohoku Univ. Technol. Reports,* 12. 4. *pp.* 12–16, 1938. *In English.*—The oscillatory motion, including the incipient stages, of a viscous incompressible fluid in a long straight tube of circular cross-section, under the conditions that (1) the motion of the liquid is everywhere parallel to the axis, and, (2) there is no axial external force except that due to the oscillatory motion of the wall of the tube, is discussed by the method of integration in the plane of the complex variable. J. S. G. T.

81. Stability of Flow between Parallel Planes. Ou Sing-Mo. *Comptes Rendus*, 207. *pp*. 715–716, *Oct*. 24, 1938.—Outlines a generalisation of a result, stated in a theorem due to Lord Rayleigh (*Sci. Papers*, 6. *p*. 197) for the stability of flow between parallel planes, for the case where the undisturbed velocity possesses a continuous derivative. W. G. B.

82. Stability of Vortex Streets. Godefroy. *Comptes Rendus*, 207. *pp*. 770–772, *Nov*. 2, 1938.—The stability of two generalised streets of point vortices in a perfect incompressible fluid is discussed mathematically. The Bénard-Kármán vortex street is dicussed as a special case. J. S. G. T.

83. Mean Velocity in Following the Movement in a Fluid in Turbulent Motion. R. Duchêne and A. Martinot-Lagarde. *Comptes Rendus*, 207. *pp*. 839–840, *Nov*. 7, 1938.—Theoretical. The results of former work [see Abstract 3937 (1938)] must not be taken as indicating that the velocity of particles parallel to the axis of the conduit is the same at all points of a perpendicular cross-section. The variation of the mean velocity is discussed. A. J. M.

84. Viscous Flow Past a Circular Cylinder. H. C. Gupta. *Phil. Mag*. 26. *pp*. 1085–1109, *Dec*., 1938.—A step-by-step method for the numerical solution of Prandtl's boundary layer equations is described and applied to the case dealt with by Green [see Abstract 3681 (1931)]. Symmetry about the diametral plane parallel to the stream is taken into account. It is believed that the new method is less laborious than Green's which is itself more direct and accurate than that of Falkner and Skan. P. H. B.

***85. Experiments on Hydraulics. G. Krall.** *Ricerca Scientifica*, 2. *pp*. 276–292, *Sept*., 1938.—This paper describes various improvements in the technique of carrying out certain hydraulic experiments, particularly a new model of a hydrodynamic tunnel. Two types are described—one for the illustration of parallel currents and the other for radial symmetrical currents. Details, including exact dimensions, of the apparatus, are given. The apparatus is fitted with illuminating lamps so that photographic records can be made. A mathematical discussion of some of the problems involved is also given. The paper also contains many photographs obtained by means of this apparatus. These include illustrations of currents within a turbine, the vortices of a paddle wheel, currents beneath a bridge and near to a rectangular projection, around a wing (using different rates of flow) and turbulence at a jet. G. G.

***86. Anemoclinometer. J. K. de Fériet, A. Martinot-Lagarde and G. Rollin.** *Comptes Rendus*, 207. *pp*. 772–774, *Nov*. 2, 1938.—The apparatus comprises a sphere having 5 orifices, appropriately disposed for measuring differential pressures in the fluid, and a Pitot tube. The differential manometer employs metallic capsules and optical registration s provided. J. S. G. T.

See also Abstracts 74, 193.

KINETIC THEORY OF MATTER.

87. Simple Derivation of the Maxwell-Boltzmann Law. E. U. Condon. *Phys. Rev.* 14. *pp.* 937–940, *Dec.* 1, 1938.—The Maxwell-Boltzmann law is derived in a direct and simple way from the usual postulates that the mechanical system has a discrete system of allowed states and that each of these states has equal *a priori* weight in calculation of statistical averages. AUTHOR.

88. Eigenvalue Problem of the Dilute Ideal Gas. W. Lenz. *Ann. d. Physik*, 33. 7. *pp.* 630–641, *Dec.*, 1938.—An earlier simplified three-dimensional treatment of the eigenvalue problem [see Abstract 714 (1929)] is now supplemented by a new method which can be generalised to the proper polydimensional problem, and consists of a modification of the Huygens principle. In consequence, the eigenvalue problem may also be treated from the standpoint of the energy-exchange during collisions. For very low temperatures—essentially below 1°—the previous " eigen " data have been confirmed. H. H. Ho.

89. Thermal Investigation of Inorganic Salts. A. T. Jensen and C. A. Beevers. *Faraday Soc., Trans.* 34. *pp.* 1478–1482, *Dec.*, 1938. —A series of inorganic salts the molecules of which were expected to perform rotational or other abnormal thermal movements were tested for λ-points by the method of differential cooling curves. The results were negative except in the case of $Ni(NO_3)_2, 6NH_3$, where a λ-point was found at $-28 \cdot 6°$ C. AUTHORS.

90. Absolute Measurements of Radiometric Action in Gases. E. Fredlund. *Phil. Mag.* 26. *pp.* 987–1000, *Dec.*, 1938.—Absolute measurements of the radiometric effect have been carried out with a series of different gases. At low pressure the well-known increase of the radiometric effect in proportion to the pressure of the gas was obtained, while at high pressure it appeared that the effect diminished in inverse proportion to the square of the gas pressure. If the radiometric effect is plotted as a function of the gas pressure in a double logarithmic diagram curves are obtained for the different gases which, by moving them up parallel to each other, can be made to coincide within the entire pressure range. A reduced radiometric curve therefore exists from which the curve for any gas can be obtained by means of a suitable transformation. The size and position of the maximum can with approximation be established according to Weber's theory of radiometric action. AUTHOR.

91. Theory of Brownian Motion. K. F. Niessen and C. J. Bakker. *Physica*, 5. *pp.* 977–985, *Dec.*, 1938. *In German.*—The treatment by H. A. Lorentz and G. L. de Haas-Lorentz of a one-dimensional motion of a particle subjected to a mechanical force K(t) is discussed and rendered more explicit than in the original version. The relation between the Ornstein correlation theory and the Einstein equation derived *via* the Lorentz impulse theory is considered. H. H. Ho.

See also Abstracts 95, 149, 383.

LENGTH, AREA AND VOLUME.

***92. Recent Continental Advances in Scientific Instruments. M. Pirani.** *Journ. Sci. Instruments*, 15. *pp.* 389–405, *Dec.*, 1938.

MATHEMATICAL METHODS AND THEORY OF MEASUREMENTS.

93. Theory of Transversal Curves and Connections between Calculus of Variations and Theory of Partial Differential Equations. M. Herzberger. *Kodak Research Lab., Comm. No.* 668. *Nat. Acad. Sci., Proc.* 24. *pp.* 466–473, *Oct.*, 1938.

***94. Automatic Detection of Maxima and Minima in the Response of an Observing Instrument. O. Bünemann.** *Manchester Phil. Soc., Mem.* 82. *pp.* 95–113, 1937–1938.—The question whether in many ways and particularly in radio direction finding the determination of control settings for maximum and minimum intensities can be automatic is discussed by treating first a similar problem in the detection of zeros. A detailed and analytic treatment of the problem is given next together with a discussion of the efficiency of the system. Finally suggestions are made for the construction of an apparatus to represent such a system. R. S. R.

95. Mechanical Elimination of Brownian and other Fortuitous Deviations in Measurements. L. S. Ornstein and J. M. W. Milatz. *Physica,* 5. *pp.* 971–976, *Dec.*, 1938. *In English.*—A method is described, which applies the known law, that, if the time of observation of some magnitude is increased by a factor p, the accuracy (or the sensitivity) can be increased by a factor $\sqrt{p}$. AUTHORS.

96. Properties of Most Plausible Line of a Set of Points Showing Errors. H. Wolf. *Zeits. f. Instrumentenk.* 58. *pp.* 429–442, *Nov.*, 1938.—The most plausible line passes through the centroid of the (weighted) observational points, and the slope is determined by a simple formula if this centroid is taken as origin. The curves showing the probable error are the branches of a hyperbola having the line as one axis. Numerical examples are worked out, and the results exhibited in diagrams. W. G. B.

97. General Graduation Formula for Smoothing of Time Series. T. E. W. Schumann. *Phil. Mag.* 26. *pp.* 970–983, *Dec.*, 1938.—A method of smoothing a series of equidistant observations, such as annual rainfalls, is described. The method is based upon the solution of a simple problem in statics. Equations are developed whereby the points on the graduated curve can be expressed in terms of the crude data, and a couple of numerical examples serve as illustrations. It is also shown that the smoothing process amounts to determining a curve such that a constant × the sum of the squares of the deviations of the crude data from the smoothed curve + the sum of the squares of the first differences of successive points on the smoothed curve is a minimum. In reality the method is a simplification of that proposed by Whittaker some 15 years ago and later elaborated by Henderson. AUTHOR.

***98. Multiple Pantograph and Etching Apparatus. J. A. Hall.** *Journ. Sci. Instruments,* 15. *pp.* 407–413, *Dec.*, 1938.—A description of the equipment used at the National Physical Laboratory for etching the mark of approval on the stems of clinical thermometers. It comprises a multiple pantograph capable of marking 36 thermometers at a time, and semi-automatic machines for applying the HF etch. AUTHOR.

See also Abstracts 12, 112, 188, 189, 283, 384, 423.

MECHANICS, CLASSICAL.

***99. Errors of Dial Gauge for Measuring Amplitudes of Vibration. H. K. Weiss.** *Rev. Sci. Instruments,* 9. *pp.* 365–369, *Nov.*, 1938.—

When used for measuring amplitudes of vibration, the dial gauge was found to have two major errors, one occurring at low frequencies, the other appearing at high frequencies. The l.f. error is caused by the weakness of the hairspring which takes up backlash in the mechanism. When the critical frequency, at which the inertia of the parts overcomes the hairspring torque is exceeded, a constant error equal to the backlash appears in the gauge reading. The h.f. error is produced by jumping of the gauge finger. By suitable installation of the gauge the jumping can be made audible to indicate the approach to the upper limit of accuracy. As the error is small for a safe range beyond this point, the audible indication provides a convenient warning. The h.f. error is postponed by using a stronger gauge spring, and by increasing the initial compression in the spring. AUTHOR.

100. Packing and Mixing of Broken Solids by a Horizontal Shaking Motion. Y. Ôyama. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 839. *pp.* 1262–1279, *Oct.*, 1938. *In English.*—The behaviour of particles of uniform size and shape contained in a vessel subjected to a horizontal reciprocating motion was investigated. The influence of the size of the particles, and of the amplitude of the motion, on the motion of the particles relative to the vessel, the closeness of packing, and the shape of the free surface of the bed of particles, is described. W. H. Wal.

See also Abstracts 114, 145, 355.

MECHANICS, QUANTUM.

101. Relativistic Commutation Rules in the Quantum Theory of Fields. Part II. M. Schönberg. *Physica*, 5. *pp.* 961–968, *Dec.*, 1938. *In English.*—The analysis of the commutation rules between field variables at different times, begun in the first part of this paper [see Abstract 3095 (1938)], is extended to more general cases, in connection with the Heisenberg-Pauli quantum theory of wave fields. This theory is discussed in connection with the wave equations of the classical field. The theory involves difficulties in the case of first order equations of motion. It is shown that the commutation rules between field quantities at different times can be determined by means of the commutation rules at the same time and the equations of motion, when these equations are linear. The case of second-order wave equations is explicitly treated, the commutation rules for the same time being known from the Heisenberg-Pauli theory. The study of the functions involved in the relativistic rules shows that the knowledge of these functions is equivalent to the complete solution of the wave equations, any solution being calculable by integrations involving the initial values. AUTHOR.

102. Hamilton-Jacobi Theory and Quantisation of a Dynamical Continuum. P. Weiss. *Roy. Soc., Proc.* 169*A. pp.* 102–119, *Dec.* 6, 1938.—The Hamilton-Jacobi theory of point mechanics is extended to the mechanics of continuous media, following on the lines first proposed by Prange. The method is based on the equivalence between the Euler equations and the " boundary formula " (*formule aux limites*) in the calculus of variations. It is shown that the notions of Lagrange brackets and Poisson brackets can be extended, but only if the Euler equations of the continuum are of hyperbolic type. Consequently, these notions only apply to a dynamical continuum and not to equilibrium problems. Except for this restriction, the method is applicable quite generally, for linear as well as for non-linear theories. Once the dynamical laws are expressed in terms of Poisson brackets, the transition to the quantum theory can be effected by a brief, formal argument in the same way as in point mechanics. [See Abstract 3491 (1936) and following Abstract.] AUTHOR.

103. Hamilton-Jacobi Theory and Quantisation of Generalised Electrodynamics. P. Weiss. *Roy. Soc., Proc.* 169*A*. *pp*. 119–133, *Dec.* 6, 1938.—A procedure of quantising a dynamical continuum [see preceding Abstract] is applied to the electromagnetic field in generalised form as given by Mie and by Born. Important special cases are the Proca field of the heavy electron, whose structure is similar to the linear case of Mie's theory, and the Maxwell field which is the linear case of Born's theory. In the theory of Mie, which is not gauge-invariant, the stress-energy-momentum tensor suggested by the mathematical procedure differs from the one defined in physics, but it is shown that both tensors lead to the same physical results. In the theory of Born, which is gauge-invariant, the "potential" of the field is described by a line-function $\oint \phi_i dx^i$ which has an absolute physical significance while the world vector (ϕ_i) has not. In this way the ambiguity concerning the stress-energy-momentum tensor is avoided. The well-known peculiar difficulties due to the "antisymmetry" of electrodynamics can be overcome by a clear formulation of the correct initial data in the classical theory. The present method is relativistically invariant throughout, so that an explicit proof of the invariance of the quantum conditions becomes unnecessary. AUTHOR.

104. Solution of Schrödinger Equation by Perturbation of Boundary Conditions. H. Froehlich. *Phys. Rev.* 54. *pp*. 945–947, *Dec.* 1, 1938.—A perturbation method is developed which allows a simple calculation of the eigenvalues of the Schrödinger equation by a slight change in the boundary condition. AUTHOR.

105. Method for Treating Large Perturbations. H. A. Bethe. *Phys. Rev.* 54. *pp*. 955–967, *Dec.* 1, 1938.—A method is developed for treating large perturbations to which the ordinary Schrödinger perturbation theory is not applicable. The method can be used for all Hamiltonian matrices which are sufficiently regular. The condition is that the matrix elements in any given diagonal should change slowly from one row to the next. It is not necessary that the Hamiltonian be expressible as an explicit function of coordinates and moments. The wave function is expanded in the usual way in "unperturbed eigenfunctions," $\psi = \Sigma_n c(n)\psi_n$. The expansion coefficients $c(n)$ are then calculated by a method similar to the well-known WKB method; only a difference is dealt with rather than a differential equation. It is found that $c(n)$ behaves, as a function of n, either exponentially or oscillatory or exponentially with alternating sign, the first two types of behaviour being similar to the ordinary WKB, while the last type is peculiar to difference equations. Several examples are given to illustrate the method, *viz.* some perturbed oscillator problems and the Matthieu functions. After some generalisations the method is applied to fast electrons in metals whose wave functions are determined in momentum space. It is shown that a plane wave is an insufficient approximation even for high energy. AUTHOR.

106. Quadrupole Contributions to London's Dispersion Forces. H. Margenau. *J. Chem. Phys.* 6. *pp*. 896–899, *Dec.*, 1938.—The contribution of terms in R^{-8} and R^{-10} to the dispersion forces is expressed by a simple, approximate formula involving only measurable quantities (polarisability, absorption frequency, oscillator strength). The formula is applicable when the dispersion curve of the substance can be represented with the use of a single resonant frequency. Numerical values of the terms in question are calculated for a number of molecules. Except in the case of the alkalies, where the convergence of the sequence in inverse powers of R fails at distances around 6Å, the R^{-10} term is generally negligible, while the R^{-8} term contributes appreciably in the region of the van der Waals minimum. AUTHOR.

107. Properties of Perfect Bose-Einstein Gas at Low Temperatures. R. H. Fowler and H. Jones. *Cambridge Phil. Soc., Proc.* 34. *pp.* 573–576, *Oct.*, 1938.—It is proved that a perfect Bose-Einstein gas has, at a certain temperature, a discontinuity in the derivative of the specific heat with respect to temperature. R. P.

108. Bose-Einstein Condensation. F. London. *Phys. Rev.* 54. *pp.* 947–954, *Dec.* 1, 1938.—A proof is given of the condensation phenomenon of a Bose-Einstein gas. A preliminary discussion of its transport properties is outlined with a view to its possible bearing on the problem of liquid He. AUTHOR.

See also Abstracts 4, 7, 11, 12, 87, 88, 233, 251, 385, 423, 425.

PHILOSOPHY OF SCIENTIFIC METHOD.

109. Foundations of Physics. A. S. Eve. *Nature,* 142. *pp.* 857–859, *Nov.* 12, 1938.—An examination of the principles of scientific method upon which leading men of science rely is made in order to demonstrate the fallacy of the distinction propounded by Stark in a recent paper [see Abstract 2720 (1938)]. The methods of research followed by Rutherford, Einstein, Faraday, Planck, the mathematical physicists, etc., are briefly summarised to show that all these investigators seek to encourage tests by experiment and observation in order to verify, to modify or to reject their ideas and theories. For example, Einstein actually named and described three fundamental observational results, which if not verified would necessitate the abandonment of the theory of relativity; this can scarcely be considered an example of dogmatism. It is pointed out that abstruse analysis such as that of Dirac led to the conception of a positive electron before its discovery in cosmic-ray researches. Thus ideas which might be termed " dogmatic " by some have led directly to the pragmatic. The gist of the matter is that the search for truth or " reality " is common to all scientific workers but there may be different avenues of approach. A. M. T.

PRESSURE.

***110. Influence of Vapour Traps on Pressure Measurements. E. Fredlund.** *Arkiv f. Mat. Astron. och Fysik, Stockholm,* 26A. 6. [12 *pp.*], 1938. *In German.*—Five vapour traps of different sizes, each trap consisting of two concentric cylindrical tubes, are joined together in series and connected to two very sensitive McLeod gauges. The difference in pressure (Δp) on either side of a trap is measured for various mean pressures (p), when the traps are cooled with liquid-air and the apparatus contains H_2. Graphs are given of Δp against p for two of the traps and of $\Delta p/p$ against log p for the other three traps. Knudsen has shown that the variation of pressure in a cylindrical tube along which there is a temperature gradient can be represented by a single equation, which is valid at all pressures. In this equation the variation of pressure is expressed as a function of the ratio of a parameter which depends only on the geometry of the tube, and the mean free path. The author derives a similar equation for the case of two concentric cylindrical tubes, but the experimental results on the five traps show that the derived equation is not valid at all pressures. S. W.

See also Abstract 387.

RELATIVITY AND ETHER.

111. Precession of the Inertial Frame of a Rotating Body. W. J. van Stockum. *Roy. Irish Acad., Proc.* 44. *pp.* 109–122, *March*, 1938.—Einstein's gravitational equations for a rotating mass of liquid of given shape in a given coordinate system are solved to a second approximation. The approximations are made with reference to powers of the quantity $8\pi G\mu/d^2$, where G is the gravitational constant and μ, d the density and the greatest linear dimension of the mass of liquid, respectively. An inertial rest-frame relative to an observer at the origin is defined by the property that the unit tangent vectors to the coordinate lines are propagated parallel to each other along the world-line of the origin. A rest-frame relative to the fixed stars is also defined and the difference between the angular velocities of rotation of these two frames is calculated. The case of a slowly rotating spheroid is discussed in detail. For a body of the size of the earth the precessional rotation of the foregoing type amounts to 13″ per century at the earth's surface. G. C. McV.

112. Solution of Einstein's Orbital Equation. S. M. Sulaiman. *Phil. Mag.* 26. *pp.* 983–987, *Dec.*, 1938.

113. System of Gravitational Equations of the First Order. G. Wataghin. *Accad. Lincei, Atti,* 27. *pp.* 570–573, *June* 3, 1938.—The results obtained in an earlier paper on this subject [see Abstract 2290 (1938)] are simplified and the gravitational equations are obtained in a new form. W. S. S.

See also Abstracts 18, 102, 103, 159, 160.

SOLUTION.

114. Statistical Mechanics of Cooperative Assemblies. E. A. Guggenheim. *Roy. Soc., Proc.* 169*A*. *pp.* 134–148, *Dec.* 6, 1938.—A regular assembly is defined as a cooperative assembly with certain simple properties analogous to those of regular solutions. The definition covers an important class of assemblies including, in addition to regular solutions, mixed crystals, solutions of H_2 in Pd and mono-layers on a surface. A general statistical treatment of regular assemblies is given, the approximation involved being equivalent to that of Bethe. The treatment given may be considered as generalising, amending and to some extent simplifying the treatment of various examples of regular assembles due to Peierls, Wang, Lacher and Rushbrooke, using Bethe's method. [See Abstracts 1214 (1935), 2291 and 3527 (1938).] AUTHOR.

115. Effect of Solvent Association on Solubility. M. J. Copley, G. F. Zellhoefer and C. S. Marvel. *Am. Chem. Soc., J.* 60. *pp.* 2666–2673, *Nov.*, 1938.—The concept of C–H←O bonds between a hydrogen of a halogenated hydrocarbon and donor atoms in solvents has been shown readily to correlate solubility data on solutions of halogenated hydrocarbons in a large number of solvents of different types. The most important factors governing the solubility of the types of compounds investigated are: (1) the donor properties of atoms in the solvent for forming C–H←O or C–H←N bonds; (2) the presence or absence of intermolecular association through H bonding in the solvent. It has been shown that it is possible to predict the type of association occurring in a liquid by means of a solubility measurement. The presence of large linear polymers in the solvent inhibits the solution of monofluorodichloromethane but if the polymerisation stops at the dimer stage nearly normal solubility is observed. [See Abstract 3106 (1938).] AUTHORS.

116. Solubility of Methylene Chloride in Donor Solvents. M. J. Copley, G. F. Zellhoefer and C. S. Marvel. *Am. Chem. Soc., J.* 60. *pp.* 2713–2716, *Nov.*, 1938.—The solubilities of methylene chloride have been determined over a range of pressure in several types of organic solvents. The solubilities are high in esters, ethers, amines and N-disubstituted amides; roughly normal in acids, N-monosubstituted amides and oximes; extremely low in alcohols and amides. The remarkable similarity between methylene chloride and monofluorodichloromethane with respect to the way in which their solubilities vary in different types of solvents shows that hydrogen bonding is also present in solutions of methylene chloride in donor solvents. AUTHORS.

117. Solubility of CO_2 in D_2O. J. Curry and C. L. Hazelton. *Am. Chem. Soc., J.* 60. *pp.* 2771–2773, *Nov.*, 1938.—The solubility of CO_2 in 99·8% D_2O at 25° has been measured relative to its solubility in H_2O at the same temperature. In terms of the Ostwald coefficient the solubilities are the same within less than 1%. On a molal basis this means that CO_2 is 0·902 times as soluble in D_2O as in H_2O. AUTHORS.

118. Distribution of Na between Molten Halides and Metal. E. Heymann and H. P. Weber. *Faraday Soc., Trans.* 34. *pp.* 1492–1501, *Dec.*, 1938.—A linear relation is found in the distribution equilibrium (at low concentration) of Na between molten NaBr or NaI as a salt phase and molten Cd as a metal phase. Thus solutions of Na in molten sodium halides are atomic in nature. The distribution curves of Na between molten sodium halide and molten Pb as a metal phase reveal the existence of strong interatomic forces between Na and Pb. When Sn, Bi, Sb and Au are used as metallic solvents, these metals pass into the salt phase together with the Na, while in the absence of Na they are inert with respect to the molten salt. These phenomena suggest that the intermetallic compounds of these metals with Na are stable in the molten state at 770° C. and soluble in the molten salt. Pb, Cd and Tl, on the other hand, do not show this phenomenon when used as metallic solvents. This is obviously due to the decomposition of the compounds of the last-mentioned metals with Na at the experimental temperature, which is 350° to 400° above their melting-point. These conclusions are in general accordance with the available thermochemical data on intermetallic compounds. The solubility of intermetallic compounds in molten salts is discussed in relation to their solubility in liquid NH_3. AUTHORS.

See also Abstracts 52, 446.

SURFACE PROPERTIES.

119. Statistical Theory of Adsorption. Part II. Theory of Two-Layer Adsorption with Correlation in the First Layer. G. P. Dube. *Cambridge Phil. Soc., Proc.* 34. *pp.* 587–598, *Oct.*, 1938.—It is assumed that atoms are adsorbed in definite positions on a surface, and that further atoms of a second layer can be adsorbed wherever four neighbouring sites, forming a square, are occupied by first-layer atoms. The statistical theory of this problem is treated on the Bragg-Williams approximation, neglecting correlations between the probabilities of occupation of different sites. However, the number of sites available for the second layer is determined by finding the probability that four corners of a square in the first layer will be occupied. This probability is worked out on the Bethe approximation, but neglecting the fact that the possibility of attaching a second-layer atom must increase the probability of simultaneous occupation of the four corners. [For Part I see Abstract 3545 (1938).] R. P.

120. Sorption of NH_3 on NaCl Crystals. F. C. Tompkins. *Faraday Soc., Trans.* **34.** *pp.* **1469–1477,** *Dec.,* **1938.**—The sorption of NH_3 on NaCl consists of an instantaneous reversible adsorption with a heat of 6,000 cal. and a slow process which obeys the laws of diffusion and is associated with a heat of activation of 6,000 cal. A theory has been put forward with regard to the mechanism of this latter process which combines the theory of activated adsorption with that of activated diffusion and a rough estimate of the activation energy based on this theory has been made, and found to agree with the experimental values. The rate measurements of Herbert are possibly complicated by cooling effects in the interior of the adsorbent and by displacement of impurities. AUTHOR.

121. Interpretation of Data by the Gibbs Adsorption Theorem. P. van Rysselberghe. *J. Phys. Chem.* **42.** *pp.* **1021–1029,** *Nov.,* **1938.**—Conventions and assumptions in the interpretation of surface-tension data of binary mixtures are briefly discussed. The concept of surface of tension is recalled. A mixture rule for the surface tension of binary mixtures involving the surface excesses of both components is proposed. This rule and the Gibbs adsorption theorem form a system of two simultaneous equations in which these surface excesses are the unknowns. It is shown that the mixture rule agrees with the familiar concepts of positive and negative adsorption usually defined by means of the convention $\Gamma_1 = 0$. The case of surface tension curves with an extremum is discussed separately. The method is applied to water-alcohol mixtures. The results show that the surface mole fraction of alcohol increases rapidly and steadily when the bulk mole fraction increases, that the surface excess of water decreases rapidly, that the surface excess of alcohol decreases after passing through a maximum near $N_2 = 0 \cdot 2$. If the inhomogeneous layer is monomolecular, the alcohol molecules, oriented perpendicularly to the surface in very dilute solutions, lie flat on the surface in pure alcohol. AUTHOR.

122. Simultaneous Sorption of CS_2 and H_2O by Activated Charcoals. J. L. Lizius and A. J. Allmand. *Roy. Soc., Proc.* **169***A. pp.* **25–44,** *Dec.* **6, 1938.**—The simultaneous sorption of H_2O and CS_2 vapours by three different activated charcoals has been studied using an elaboration of technique already described. Measurements have been made of the adsorption isothermals of CS_2 on charcoals containing a constant charge of sorbed water, of the effect of variations in water charge on the pressure exerted by a constant charge of sorbed CS_2 and, over a limited range, of the H_2O vapour isothermals on such charcoals. Minor complications were observed, due to slow displacement of surface oxides and of adsorbed CS_2 by sorbed water, and to slow uptake of the latter by hygroscopic material present in one of the charcoals. The results in general are consistent with our previous knowledge of the different charcoals, and with the conception that water is sorbed on a clean charcoal surface at low pressures as a disperse layer of single and double molecules, that at higher pressures a continuous surface film is gradually formed which covers the whole available area at saturation, and that irreversible capillary condensation accompanies the formation of this film. AUTHORS.

123. Adsorption of Alkali by Wool. J. Powney and C. C. Addison. *Faraday Soc., Trans.* 34. *pp.* 1439–1445. *Dec.*, 1938.—The adsorption and desorption of caustic soda by purified Merino and Lincoln wools has been investigated by means of a conductivity method over a range of temperatures. Some data for the adsorption of alkali on mohair are also included. The results confirm the observation of McMahon and Speakman that root wool which has been unexposed to light adsorbs little alkali below pH10. Samples of fine Merino wool having high surface area showed appreciably greater adsorption of NaOH than did the coarser Lincoln wool. The differences, however, are not as great as would have been anticipated had the adsorption been purely a surface effect. Desorption of alkali from wool follows the same principles as adsorption, except under conditions of very low alkali content when anomalous effects are observed. AUTHORS.

124. Adsorption from Binary Mixtures by Charcoal and Silica Gel. J. G. Kane and S. K. K. Jatkar. *Indian Inst. of Science, J.* 21*A*. 28. *pp.* 331–344; 21*A*. 33. *pp.* 385–394; 21*A*. 35. *pp.* 407–411, and 21*A*. 36. *pp.* 413–416, 1938.

125. Interfacial Tensions of Pure Soap Solutions. B. S. Kulkarni and S. K. K. Jatkar. *Indian Inst. Sci., J.* 21*A*. 34. *pp.* 395–405, 1938.—Interfacial tensions against benzene, of aqueous solutions of Na and K soaps of the homologous series are measured and the results compared with corresponding surface tension measurements by other workers. The results are discussed in the light of the previous theories on the subject and explanations are given for the maximum activity shown by the myristate, and for the increased activity due to unsaturation, presence of hydroxyl group and replacement of Na by K in the soap molecule. The various units participating in the soap solution equilibria, appear to possess surface activity to a smaller or greater extent; the simple ions of the soaps of the lower series due to their higher osmotic activity, and the aggregated particles of the higher series of fatty acids, due to their less sensitivity to the surface forces, appear to be less surface-active than the simple molecules. As these are entirely dissociated, it would appear that the surface activity is mainly dependent upon the nature of the anions. As the latter get concentrated at the surface the kations form a double layer with oriented anions. The difference between the surface activity Na, K and even NH_4 and Li soaps observed by different workers, thus appears to be due to the fact that the entire soap molecule gets concentrated at the interface. AUTHORS.

126. Boundary Tension by Pendant Drops. J. M. Andreas, E. A. Hauser and W. B. Tucker. *J. Phys. Chem.* 42. *pp.* 1001–1019, *Nov.*, 1938.—A new method is developed by which the boundary tension can be computed readily from the densities of the liquids tested and simple measurements made on a photograph of the silhouette of a hanging drop. With the existing apparatus results having a probable error of about ± 0·5% are obtained. With special high precision apparatus, and a more precise determination of a mathematical function connecting drop shape with boundary tension, results accurate to ± 0·05% should be obtainable. Among the results presented are some not previously available, and it is shown that liquid-liquid interfaces are relatively more affected by surface-active materials than are liquid-gas interfaces, also that boundary tensions may either increase or decrease during ageing of the surface. Suggestions as to the possible reasons for the observed phenomena are offered. Many advantages and spheres of application are claimed for the method. P. H. B.

127. Surface Tension of Mercury by Maximum Bubble Pressure Method. R. C. L. Bosworth. *Faraday Soc., Trans.* 34. *pp.* 1501–1505, *Dec.*, 1938.—An attempt is made to measure the surface tension of Hg by the maximum bubble pressure method, and it is found that under different conditions two types of bubble may be formed at a stainless steel jet dipping into Hg. By using jets of different external and internal diameters it is shown that these two types correspond to bubbles breaking from the external and internal edge of the jet respectively. The surface tension calculated from the pressures in these two types of bubbles differed by 3%. When a metal with zero contact angle to Hg was used for the jets only one type of bubble was obtained, its behaviour corresponding to the external bubble above. The value obtained for the surface tension of Hg by these experiments 484 dynes/cm. at 20° C., and its temperature coefficient is 0·21 dynes/cm./°C. Bubbles of CO_2 as well as air were used, and the surface tension in the presence of CO_2 proved to be only 1% lower than in the presence of air. AUTHOR.

128. Adsorption of Constituents of a Solid Phase on the Surface. S. Dobiński. *Acad. Polonaise Sci. et Lettres, Bull.* 3–5*A*. *pp.* 169–178, *March–May,* 1938. *In English.*—The adsorption of the constituents of a solid phase on the surface was investigated by examining the surface films formed when Cu containing 0·01% S was heated *in vacuo*. The Cu was at first polished and then etched with HNO_3. The electron diffraction pattern was normal for Cu. After heating to 800° C. *in vacuo* for 4 hr., the electron diffraction pattern given by the surface was that of CuS. It was considered that all the metallic Cu had been displaced to the depth of a few tenths of 1Å by CuS. Polishing of the surface gave similar results due to the considerable rise of temperature during polishing. The same effects were obtained with brass, containing 71% Cu and 29% Zn and with an alloy of 98% Cu and 2% Be. F. J. B.

129. Structure of Surfaces of Solutions. T. F. Ford and D. A. Wilson. *J. Phys. Chem.* 42. *pp.* 1051–1061, *Nov.*, 1938.—A new technique is developed for the investigation of soluble films of positively adsorbed solutes upon the surfaces of their solutions. Films of solute molecules have been shown to exist upon aged surfaces of solutions of caprylic acid, hydrocinnamic acid, and phenol, whereas the surfaces of freshly swept solutions seem more nearly to resemble water. The analogy between these films of adsorbed solute molecules and two-dimensional insoluble films is demonstrated. The amount of solute in these soluble films is found to be of the same order of magnitude as predicted by the Gibbs theorem. AUTHORS.

130. Nature of Surface Layers of Thin Ground Quartz Crystals. F. R. Hirsh, Jr. and J. W. M. DuMond. *Phys. Rev.* 54. *pp.* 789–792, *Nov.* 15, 1938.—Experiments on polished quartz crystals with a Cauchois transmission-type curved crystal X-ray spectrograph show that (1) the mechanical stress due to bending existing in the main body of the crystal is not shared by the surface layers, (2) the surface layers are crystalline and have the grating constant of unstrained quartz, (3) the atomic planes in the surface layers have the same orientation as the planes in the main body of the crystal. It is shown that the results are in agreement with the work of Finch [see Abstract 1458 (1937)] on the recrystallisation of the polish layer on quartz crystals. A. G. Q.

131. Electron Diffraction and Surface Structure. *Phys. Soc., Proc.* 50. *pp.* 961–967, *Nov.* 1, 1938.—A report of a discussion held at a joint meeting of the Chemical Society and the Physical Society.

G. I. Finch contributed the opening paper [see Abstract 4362 (1938)], a summary of which is given.

R. Beeching emphasised that electron diffraction could not be applied to all types of specimen and that the lack of a satisfactory theory had hampered the development of the subject.

A. G. Quarrell stressed the importance of the reflection method, described the application of split-shutter technique to reflection specimens and gave an account of a new method of back-reflection of electrons [see Abstract 4227 (1938)].

W. Cochrane discussed the application of electron diffraction to the determination of submicroscopic surface form from the appearance of irrational diffractions.

W. H. J. Vernon agreed that an amorphous surface film as a rule conferred a greater protection than a crystalline one and that the initial condition of the metal surface was an important factor. He urged the closest possible cooperation between electron diffractionists and those applying other methods to the study of thin films.

J. A. Darbyshire gave the results of an investigation of oxide coated kathodes [see Abstract 3840 (1938)].

H. Wilman dealt with the electron diffraction patterns afforded by colloidal graphite particles and showed how X-ray investigation might lead to false views of crystal form and size in the case of thin flake-like crystals.

R. O. Jenkins described the investigation of oxide films on the surfaces of molten metals [see Abstract 479 (1935)]. A. G. Q.

132. Parachors and Thermal Conductivity of the Metallic Elements. B. N. Sen. *Gazz. Chim. Ital.* 68. *pp.* 307–311, *May*, 1938.—From a review of the theory of "free" electrons the author deduces a relation for calculating thermal conductivity κ from the parachor P, atomic diameter $2r$, atomic weight m, atomic number n, atomic frequency ν, number of "free" electrons per atom (equal to the valency), and the closest distance of approach of the atoms concerned. The relation is $\kappa = K(2rd/Pn)(m/N)\nu$, N being Avogadro's constant ($6{\cdot}06 \times 10^{23}$) and K a constant depending on the atomic lattice and the number of "free" electrons. Consistent results are obtained. D. R. H.

133. Organic Parachors. Part I. Isomeric Esters. O. R. Quayle, K. Owen and R. R. Estes. *Am. Chem. Soc.*, J. 60. *pp.* 2716–2719, *Nov.*, 1938.—The surface tensions of 15 normal isomeric esters ($C_{16}H_{32}O_2$) have been measured at 25, 35, 50, and 65° by the method of maximum bubble pressure. The calculated parachors were found to decrease gradually from maxima of 695·3 and 699·1 at the ends of the series to a minimum of 689·3 near the centre of the series. Molecular volumes calculated from densities taken at constant surface tension (27 dynes/cm.) varied similarly to parachor. The parachors were found to increase, in general, with the temperature. AUTHORS.

134. Structure of Rubber Films. K. Tanaka. *Kyoto Coll. Sci., Mem.* 21. *pp.* 169–172, *Sept.*, 1938. *In English.*—The molecular structure of thin rubber film, deposited from its benzene solution on a polished metal surface by evaporating the solvent benzene, was examined by the method of electron diffraction at various temperatures, and it was found that rubber molecules arranged themselves similarly to those of paraffin crystals. [See Abstract 4367 (1938).] AUTHOR.

135. Structures of Iron Films Deposited on Annealed Rock-Salt. S. Shirai. *Phys. Math. Soc. Japan, Proc.* 20. *pp.* 855–859, *Oct.*, 1938. *In English.*—Iron films have been deposited on the annealed cleavage surface of rock-salt by evaporation *in vacuo*, and the effect of the annealed surface on the structure of the iron films has been examined by the transmission of kathode rays. The evaporating apparatus and the electron camera used were the same as those described in a previous paper [see Abstract 81 (1938)] but differences in the patterns obtained are now revealed. The latter may be due to the more perfect smoothness of the annealed surface of the base, and also to the fact that the iron atoms when they solidified themselves in a film would be free from disturbances by the atoms of gases which had been absorbed and adsorbed by the rock-salt. H. H. Ho.

136. X-Ray Reflections from Fe Films. G. Borrmann. *Zeits. f. Krist.* 100. 3. *pp.* 228–233, 1938.—In these experiments the reflected beams obtained on the passage of X-rays through thin plates of crystals, about 10^{-2} mm. thick, are recorded. The material used was chiefly Fe, though Ag and Cu were also used; the X-ray tube had a Cu anti-kathode. Dark and bright curved lines were obtained in the photographic record. An explanation of this effect is given in terms of the production, reflection, and absorption of Fe $K\alpha$ radiation in the crystal plate. If the plate was a little thicker the effect was more marked especially with the [200] reflection; with thinner plates many of the lines were very weak. The question of mosaic and ideal crystal structures is also considered. G. G.

137. Determination of Three Principal Dimensions of Molecules. H. Devaux and L. Pallu. *J. de Physique et le Radium*, 9. *pp.* 441–446, *Oct*, 1938.—Study of the behaviour of lentils, rape seed and groat grains on a Hg surface during gradual compression reveals clearly their parallel behaviour to that of molecules in a surface film. It suggests how the three principal dimensions of such molecules may be calculated from the critical phases which occur during compression. P. H. B.

138. Molecular Interaction in Mixed Monolayers. Part I. Mixtures of Alcohols, Acids and Amines. Part II. Unstable Mixtures with Unsaturated Acids. W. D. Harkins and R. T. Florence. *J. Chem. Phys.* 6. *pp.* 847–860, *Dec.*, 1938.

139. Increase in Viscosity of Mineral Oil at Rest. A. Marcelin. *Comptes Rendus*, 207. *pp.* 777–779, *Nov.* 2, 1938.—The motion of a ball on an inclined plane submerged in a mineral oil has been observed. The ball does not run in straight lines, but its velocity and direction of motion vary as if it met obstacles. [See also Abstract 4826 (1938).] A. J. M.

140. Forces between Charged Surfaces in Water, and the Jones-Ray Effect. I. Langmuir. *Science*, 88. *pp.* 430–432, *Nov.* 4, 1938.—The repulsive force between two positively charged and closely adjacent planes in a dilute salt solution is found by applying the Poisson and Boltzmann equations. It is of the right magnitude to account for the formation of tactoids and unipolar coacervates. The limiting thickness of the liquid film draining from a highly charged plate held vertically in the surface of a dilute electrolyte is also calculated, and an extension to capillary tubes is made. Rough calculations are given to support a theory that the apparent lowering of surface tension produced by the solution of extremely small quantities of electrolytes [see Abstract 1074 (1937)] can be adequately explained on the basis of a water film held on the surface of the capillary tube by electric charges bounded by the quartz. The paper is stated to be only preliminary in nature. P. H. B.

141. Interfacial Tension, pH and Chemical Constitution. R. A. Peters and R. W. Wakelin. *Faraday Soc., Trans.* 34. *pp.* 1537–1539, *Dec.,* 1938.—The fall in interfacial tension (benzene-water interface) of octadecylamine, on passing towards a less alkaline phase is similar to that of hexadecylamine. From this it is concluded that long C chain amines show interfacial changes in ionisation at a less alkaline pH than amines ionising in a bulk phase. The presence of an —OH group shifts the apparent pK for a long chain fatty acid at an interface towards the acid side as compared with the simple fatty acid. AUTHORS.

142. Light Action and Runge's Capillary Pictures. R. E. Liesegang. *Zeits. f. wiss. Phot.* 37. *pp.* 160–162, *July–Aug.,* 1938.—Briefly examines the effect of light on the formation of the browny-red Runge rings and zig-zag capillary lines. The rings are formed by allowing drops of a 5% $Co(NO_3)_2$ solution to fall on to filter paper soaked in a 2% K_2CrO_4 solution, and the zig-zag capillary lines are obtained by supporting saturated filter paper so that it hangs vertically with its bottom edge in the $Co(NO_3)_2$ solution. R. C. F.

See also Abstracts 24, 49, 114, 147, 385, 426 and
8B. Lubricants. Part I. Y. Suge.

TIME.

143. Tidal Variations in Length of the Day. F. Andersson. *Arkiv f. Mat. Astron. och Fysik, Stockholm,* 26*A*. 8. [34 *pp.*], 1938. *In German.*—The deformation of the figure of the earth by tidal forces is considered, and the resulting variation in the length of the day calculated. The effect is attributed to an alteration in the moment of inertia of the earth as its axis of rotation varies. The variations occur in periods of 0·5 month, 0·5 year, and 18 years, with amplitudes respectively of 0·001, 0·008, and 0·278 sec. in the length of the hour. A. Hu.

***144. Changes of Rate of Clocks at Greenwich and Göttingen. R. d'E. Atkinson.** *Zeits. f. Physik,* 111. 1–2. *pp.* 133–136, 1938.—An account is given of the way in which the performances of 5 Shortt clocks at Greenwich and one at the N.P.L. are combined to form the basis of the Rugby time signals. The corrections to these time signals have little relation to the errors of any particular clock, and an apparent parallelism between the corrections to the signals and the performances of the Schuler clocks cannot be explained as suggested by Gockel and Schuler [see Abstract 3560 (1938)]. P. H. B.

***145. A.C. Maintenance of Pendulum Movement. J. Béthenod.** *Comptes Rendus,* 207. *pp.* 847–849, *Nov.* 7, 1938.—Cornu has previously studied the method of maintaining pendulum movement by a periodically interrupted current and, based on his principles, the present author in collaboration with A. Soulier has constructed an electric clock which is operated by a.c. flowing through a solenoidal device, arranged so that no direct contact occurs. The theory of this instrument is now developed, and the phenomenon treated constitutes a remarkable example of the maintenance of oscillation by a unique source of sinusoidal energy of any frequency whatever ; the process differs from ordinary methods of reducing frequency. H. H. Ho.

See also Abstract 160.

VISCOSITY AND FRICTION.

146. Rotation of a Cylinder in a Viscous Fluid. Part I. T. Sakurai. *Phys. Math. Soc. Japan, Proc.* 20. *pp.* 833–849, *Oct.,* 1938. *In English.*—The paper deals with the slow steady rotation of a cylinder about an axis parallel to a generating line. The fourth-order differential equation is deduced, and with the aid of ker and kei functions solutions are found for the motion produced at any place in the viscous fluid including the region of the wall of the cylinder, and also for the resistance to the motion of the cylinder. P. H. B.

***147. Internal Friction and Lubrication. H. Harms, H. Rössler and K. L. Wolf.** *Zeits. f. phys. Chem.* 41. *Abt.B.* 5. *pp.* 321–364, 1938.—A molecular theory of internal friction in liquids is developed, with a view to establishing the dependence of viscosity upon other properties, and the theory has been tested by applying it to the results of a series of experiments with a large number of liquids. The connection between the changes in internal friction occurring in a mixture and the intermolecular forces is demonstrated. Full details are given of the viscosity apparatus employed and also of a magnetically controlled water tap which enabled a thermostat to be maintained at 6° ± 0·01° C. [See also Abstract 3330 (1937).] A. G. Q.

148. Nuclear Viscosity and Thermal Conductivity. S. Tomonaga. *Zeits. f. Physik,* 110. 9–10. *pp.* 573–604, 1938.—Calculations of the viscosity and thermal conductivity of nuclear substances are made on the basis of the Fermi gas-model. At low temperatures the viscosity is shown to be proportional to T^{-2} and the thermal conductivity to T^{-1} ($T = {}^\circ$Abs.). The viscosity then becomes sufficiently large for the nuclear vibrations to be damped out, and the energy of excitation of the atomic nucleus is retained as heat. The thermal conductivity also becomes large, and the heat is very quickly dissipated in the nucleus. This justifies the usual assumption that the time of propagation can be neglected in nuclear reactions. It is, however, possible for this time to become perceptible under special circumstances, as, for example, during the collision of the atomic nucleus with a particle of very high energy. R. W. P.

149. Particle-Form Dependence of Viscosity of Dilute Solutions and Suspensions. A. Peterlin. *Zeits. f. Physik,* 111. 3–4. *pp.* 232–263, 1938.—The calculation of the specific viscosity of attenuated suspensions of solid ellipsoidal shaped particles is strictly carried out. For this the distribution function of the axes of the particles must be established. Through the alternating action of the Brownian motion and the flow there results as consequence of the orientation of the suspended particles a dependence of the specific viscosity on the pushing tension which can be explained as structural viscosity. For its coming into action a definite magnitude of the particles is requisite. Smaller particles exhibit a constant specific viscosity which corresponds with the case of total Brownian movement: with larger particles there appears a temporary fluctuation of the specific viscosity. J. J. S.

150. Viscosity of H_2 and D_2. A. van Itterbeek and A. Claes. *Physica,* 5. *pp.* 938–944, *Dec.,* 1938. *In English.*—Measurements are made on the viscosity of H_2 and D_2 (purity 99·6% in weight) at room-temperature, and at temperatures obtained with liquid O_2 and H_2. At room-temperature $\eta_{D_2}/\eta_{H_2} = 1\cdot39$, which is in agreement with the classical theory of viscosity. At lower temperatures there is a gradual decrease of this ratio; at temperatures of liquid O_2 it is equal to 1·35 and at liquid H_2 temperatures to 1·24. The authors do not believe that this decrease can be attributed to the presence of the small quantity of H_2 in the D_2-gas. [See Abstract 1878 (1938).] AUTHORS.

151. Viscosity of Argon. A. van Itterbeek and O. van Paemel. *Physica,* 5. *pp.* 1009–1012, *Dec.,* 1938. *In English.*—The viscosity of A was determined at room-temperature and at 11 temperatures obtained with liquid O_2 and solid N_2. In the low temperature region, the viscosity can be represented by means of the following formula: $\eta = \eta_{90}(T/90)^{0.883}$, with $\eta_{90} = 759\cdot2\cdot10^{-7}$. It was not possible to describe the results by means of one of the potential functions computed by Lennard-Jones. AUTHORS.

152. Slow Changes in Physical Properties of Glasses. E. Seddon. *Soc. Glass Technol, J.* 22. *pp.* 268–308, *Oct.,* 1938.—In an investigation of the effect of time on the physical properties of glass at atmospheric temperatures, the electrical resistance of specimens of soda-silica glass, of approximate composition 20% Na_2O, 80% SiO_2, was found to increase over periods up to three years. This rise in resistance is explained in terms of microscopic flow within the glass, *i.e.,* by readjustments of the atomic structure, the initial form of which as well as its rate of modification with time, depended upon the previous thermal history of the sample. The present tests showed that after an initial period there was a logarithmic relation between resistance and time of a nature similar to that found for other properties by previous investigators, although some of the older tests were made at higher temperatures on glasses of different chemical compositions. A brief review of available information is included. If flow at room-temperatures is accepted as proven, the best description for the present soda-silica glass at all temperatures below its softening zone appears to be "an undercooled liquid of high but finite viscosity," a description which can be reconciled with present-day views of the structure of such glasses from X-ray examination. AUTHOR.

153. Effect of Magnetic Fields on Viscosity of Gases. H. Senftleben and H. Gladisch. *Ann. d. Physik,* 33. 5. *pp.* 471–476, *Nov.,* 1938.—In continuation of earlier work [see Abstract 502 (1938)] it is now shown that before it is possible to compare the results for the change in viscosity $-\Delta\eta$, due to a magnetic field with those for change in thermal conductivity, $-\Delta\lambda$, allowance has to be made for the effect of change of pressure on viscosity. This is done, and it is then found that at all values of H/p the ratio $(\Delta\lambda/\lambda)/(\Delta\eta/\eta)$ has a nearly constant value of 1·7 to 1·8. In addition, the curve of $(\Delta\eta/\eta)_{O_2}/(\Delta\eta/\eta)_{NO}$ against H/p coincides with the corresponding curve for the ratio of the changes in thermal conductivity of O_2 and NO. R. W. P.

See also Abstracts 20, 74, 343, 424.

ASTRONOMY AND ASTROPHYSICS.

ASTRONOMICAL APPARATUS AND OBSERVATORY EQUIPMENT.

***154. Use of Aluminium-on-Glass Gratings in Victoria Stellar Spectrograph. C. S. Beals and A. McKellar.** *Roy. Astron. Soc. Canada, J.* 32. *pp.* 369–375, *Oct.*, 1938.—The discovery of duplicity of interstellar Ca lines in spectra of some Orion stars and ρ Leonis, made it desirable to examine the interstellar Na D-lines of these stars. To get adequate dispersion and resolving power in the yellow region it was necessary to obtain very fine gratings ruled on Cr-Al evaporated on to pyrex glass blanks, and R. W. Wood has produced one of this type about $3\frac{1}{4}$ in^2. (15,000 lines/in.) with the first order very strong, and a second one with the second order very strong also. The mounting of a grating in the Victoria spectrograph is described, plans are figured and a plate is given. Another figure shows microphotometer tracings of spectra of P Cygni, α Cygni and ϵ Orionis in the D-line region taken with three prisms and the first- and second-order gratings respectively, and indicates the existence of discrete interstellar clouds having their own individual motions. A. S. D. M.

***155. Simplified Spectrohelioscope. G. A. Mitchell.** *Mt. Wilson Observat. Contrib. No.* 599. *Astrophys. J.* 88. *pp.* 542–547, *Dec.*, 1938.—The article describes the construction of a rotating-disc spectrohelioscope provided with two or three sets of slits of different width and an adjustable shutter which permits a choice of slit width without stopping the disc. A device for eliminating inclination of the spectrum lines is also provided. The modified design is such that all the mechanical work except that on the head plate can be done with a breast drill, file, and a few taps. AUTHOR.

156. Definite Orbit of Comet Finlay. M. Cimino. *Accad. Lincei, Atti,* 27. *pp.* 668–675, *June* 19, 1938.—The author calculates corrected values of the orbital elements of the comet Finlay. He uses the observations obtained by different observatories in 1919. 18 observations are excluded which are erroneous or dubious in one coordinate. By using the elements calculated by Crawford, Fairfield, and Cummings, the corrected orbital elements are calculated with the method of the variation of the elliptical elements. The new values for the definite orbit are : T·= 1919, Oct. 15·47265 ; $\phi = 45^\circ 38' 19\cdot 22''$; $\mu = 529''\cdot 7833$.

$$\left.\begin{aligned}\omega' &= 359^\circ 54' 52\cdot 86''\\ \Omega' &= 5^\circ 41'\ 1\cdot 90''\\ i' &= 25^\circ 52' 53\cdot 07''\end{aligned}\right\}\text{Equ. 1919·0}\qquad \left.\begin{aligned}\omega &= 318^\circ 10' 59\cdot 96''\\ \Omega &= 46^\circ 53' 54\cdot 65''\\ i &= 3^\circ 23' 40\cdot 05''\end{aligned}\right\}\text{Ecl. 1919·0}$$

L. K.

See also Abstracts 168, 281.

COMETS AND METEORS.

157. Photographic Meteor Studies. Part I. F. L. Whipple. *Am. Phil. Soc., Proc.* 79. 4. *pp.* 499–548, 1938.—Radiants, heights, velocities and decelerations have been measured for six meteors photographed simultaneously with two cameras, one equipped with a rotating shutter. The velocity measured for a Perseid shower meteor agrees well with the known velocity of the associated comet. A Geminid is found to have been moving in an orbit with period 1·8 years. Of four sporadic meteors studied, three are found to have been moving in short-period orbits with very small inclinations to the plane of the ecliptic. The fourth sporadic meteor was moving with retrograde motion in a nearly parabolic or possibly hyperbolic orbit. The measures of deceleration coupled with measures of velocity and luminosity provide a rough determination of the fraction of the relative kinetic energy of the air molecules available for heating the nucleus of a meteor. The theories by Öpik and Hoppe are the fundamental basis of these calculations and for determinations of atmospheric densities at heights from 58–99 km. above the earth's surface. A density-distribution curve in the atmosphere is derived from other physical observations ; the densities determined from the meteor data are compared with the values from this curve. A seasonal effect with a total amplitude of 0·5 in log density is suggested by the observations. Formulæ are derived for the determination of meteor velocities from less complete observational material. AUTHOR.

COSMOGONY.

158. Fundamental Problems of Cosmogony and Newton's Laws. G. Armellini. *Accad. Lincei, Atti,* 27. *pp.* 609–614, *June* 19, 1938.—Continuation of a previous paper [see Abstract 1016 (1938)]. The author concludes that if the law of attraction as given in his modification is assumed the structure of the planetary system is explained without having any need to have recourse to particular cosmogonic hypotheses. J. J. S.

159. Milne's Theory of Relativity, Cosmology and Gravitation. C. W. Oseen. *Arkiv f. Mat. Astron. och Fysik, Stockholm,* 26*A*. 4. [5 *pp.*], 1938. *In German.*—A short discussion of the meaning of a physical law is followed by an account of Milne's fundamental hypotheses which are shown to be equivalent to those of special relativity. General relativity, it is argued, lies outside the scope of Milne's theory. G. C. McV.

160. Accelerated and Decelerated Linear Equivalence. J. B. Reid. *Zeits. f. Astrophysik,* 16. 5. *pp.* 333–342, 1938. *In English.*—A general method for investigating the properties of any linear equivalence is developed. Two new linear equivalences are described. Both start from the same initial condition as the uniform motion equivalence. The first accelerates until its members are completely dispersed and all travelling away from each other with the velocity of light. The second decelerates, each member coming to rest at a uniform distance from his neighbours, the equivalence finally approximating to the relatively stationary equivalence. These new accelerated equivalences differ notably from Page's in that they start off with finite velocities and in that it is always possible for any member to send out a signal which will reach any other member within a finite time. [See Abstract 2752 (1938).] AUTHOR.

DYNAMICAL PROBLEMS (ASTRONOMICAL).

See Abstract 111.

NEBULÆ.

161. Theory of Colours of Reflection Nebulæ. L. G. Henyey and J. L. Greenstein. *Astrophys. J.* 88. *pp.* 580–604, *Dec.,* 1938.—A theory based on a rigorous treatment of the transfer of radiation through a nebula is needed to interpret observations of the colours of reflection nebulæ. Nebulæ are, in general, bluer than the illuminating stars because of the greater scattering coefficient of interstellar material in blue light. The nature of the relative colour of nebula and star is studied for several different geometrical configurations by the use of idealised models. If the star is in front of the nebula, the colour of the nebula will approach that of the star with increasing total opacity. If the nebula is in front of the star, it will always be bluer than the star. The validity of certain approximations used in this discussion is investigated. Possible variations of the scattering efficiency, or albedo, with wave-length can contribute strongly to the colours of the nebulæ. The properties of small particles, relevant to the problems of nebular illumination, are derived on the basis of the Mie theory. The observed dependence of the extinction coefficient upon wave-length may be explained by the presence of metallic particles, or of an appropriately chosen mixture of dielectric particles of various sizes. The albedo of metallic particles is small and varies with wave-length, providing a possible test for the existence of metallic substances in space. The phase function for small particles of various substances is also studied. AUTHORS.

162. Temperatures of Extragalactic Nebulæ and Red-Shift Correction. J. L. Greenstein. *Astrophys. J.* 88. *pp.* 605–617, *Dec.*, 1938.—The spectral energy distribution in nebulæ can be measured with the new nebular spectrographs at the Yerkes and McDonald observatories. The mean energy-curve (based on seven plates) of the Andromeda nebula relative to stars of known colour temperature is given in the figure. From λ 6500 to λ 3900 it closely resembles that of a black body of temperature 4200°. A calibration of temperatures from colour indices is therefore justified. The mean colour temperature of the nebulæ lies between 4700° and 5250°. The effect of such low temperatures on the present interpretation of the counts of extragalactic nebulæ is serious. It seems improbable that the effect of the red shift on the apparent magnitudes of the nebulæ, found by Hubble, can be interpreted either as a velocity or as a nonvelocity shift. The effect of absorption lines, and of a possible u.v. excess, on the energy distribution and on the magnitude corrections is briefly investigated. AUTHOR.

PLANETS.

163. Internal Constitution of Planets. P. Sen. *Zeits. f. Astrophysik*, 16. 5. *pp.* 297–303, 1938. *In English.*—The theory of pressure ionisation, as has been shown by Kothari and Majumdar [see Abstracts 2590 (1936) and 1911 (1938)], when combined with the usual theory of the white dwarf stars predicts a maximum radius for a cold body and explains the broad features of the constitution of planets. Kothari has discussed two extreme cases when the material composing the planets is all H or Fe. In the present paper the mass-radius relation is calculated for the case of CH_4, NH_3 and H_2O. The method is indeed very rough but it serves to show how the theoretical (M, R) relation is modified when the chemical composition is changed. The theory suggests that the outer planets are probably composed of CH_4 and NH_3 with a proportion of H_2 and the terrestrial planets have cores of heavier elements. AUTHOR.

164. Planets from Observations at Lowell Observatory. E. C. Slipher. *Am. Phil. Soc., Proc.* 79. 3. *pp.* 441–473, 1938.—This observatory has emphasised the study of the planets since 1894, and the present paper briefly discusses the observations of Mercury, Venus, Mars, Jupiter,

and Saturn, and their atmospheres. Direct photographs portray the general appearance of these planets, significant changes, as well as examples of tell-tale phenomena observed during the past 30 years. Mercury appears as atmosphereless and unchangeable as our moon and, keeping always the same face to the sun, thus is completely desolated by a surface temperature of 280° to 400° C. Venus' true surface is hidden by a considerable atmosphere, rendered virtually opaque by some medium, probably dust, and hence her day is not yet definitely determined but is long. Her atmosphere contains 400 to 500 metre-atmospheres of CO_2, but O_2 and H_2O have not yet been detected. The temperature of her actual surface is more difficult to determine than Mercury's, but appears about 50° C. Mars is analogous to the earth, and its surface is marked by polar snow-caps and blue-green areas which change with its seasons, has a moderate surface temperature, and displays an atmosphere of considerable extent which supports clouds at relatively great heights and scatters light to an amazing degree, but is very changeable in the latter respect. Jupiter presents a belted surface of mobile, changeable, and vari-coloured clouds of unknown composition, but not of water-vapour. The surface temperature is low—near $-120°$ C., but the great activity of his surface indicates a fairly hot interior. His overlying atmosphere, containing CH_4 and NH_3, is very transparent although of a molecular population comparable with the earth's. Saturn closely resembles Jupiter, but its surface displays less activity and less conspicuous markings except in rare instances such as the great white spots of 1875 and 1933. The surface temperature is near $-150°$ C., and the composition and behaviour of its upper atmosphere simulates Jupiter's.
AUTHOR.

165. Trans-Neptunian Planet Search. V. M. Slipher. *Am. Phil. Soc., Proc.* 79. 3. *pp.* 435–440, 1938.—The author describes the search for more distant members of the solar system, such as Pluto found in 1931; the manner of search is to photograph the identical region of the sky, using the same guide star on two different plates, two or a few nights apart, for then the distant planet will be shifted a little on the two plates by the swift movement of the earth in its orbit. The two members of these pairs of duplicates are tested under the Blink comparator machine. The observer has already examined every star for planetary motions in 27,000 square degrees, or 65% of the whole sky. A map is given in illustration. The number of stars examined is 35,000,000, or 70,000,000 images.
A. S. D. M.

STARS.

166. Trigonometric Parallax, Magnitude and Spectrum of White Dwarf in Auriga (Ci. 20, No. 398). S. Asklöf and J. M. Ramberg. *Arkiv f. Mat. Astron. och Fysik,* 26*B*. 8. [6 *pp.*], 1938. *In English.*—Asklöf found that the parallax of this faint star of $12^{m \cdot}$ is $-0''178$, and he asked Ramberg to study its spectrum. The latter photographed it with the 40-cm. Zeiss astrograph, combined with objective prism, for 1 hr.; it gave an A-spectrum with the $H\gamma$ and $H\delta$ lines very wide and diffuse; its photographic magnitude came out as $M_{phg} = 11 \cdot 0$ so it was obviously a white dwarf. No K line can be seen so its spectral type is A0. Tracings of it show all the white dwarf characteristics: very strong widening of $H\gamma$ and $H\delta$ and weakening of the high-numbered Balmer lines. $H\epsilon$ is the last Balmer line clearly visible, so its surface gravity must be greater than that of o_2-Eridani. The u.v. lines are much

more intense than in ordinary A-stars, indicating almost complete absence of continuous H-absorption, which is probably typical of all white dwarfs.
A. S. D. M.

167. Empirical Mass-Luminosity Relation. G. P. Kuiper. *Astrophys. J.* 88. *pp.* 472–506, *Nov.*, 1938.—The derivation of empirical mass-luminosity is treated in three sections: (1) visual binaries of which data for 30 are given in a table; (2) eclipsing binaries which include double-line spectroscopic binaries that are also eclipsing variables for which the mass ratio may be measured and the magnitude difference found by spectrum photometry. A table is given of representative objects. Some close binaries with nearly equal components are discussed; (3) Trumpler's massive stars of very luminous A- and B-types in galactic clusters, because their masses have been determined by the Einstein shift. A table is given of 7 of these objects which are also shown graphically in two diagrams. [See Abstract 184 (1939).]
A. S. D. M.

***168. Limiting Magnitudes. F. E. Ross.** *Astrophys. J.* 88. *pp.* 548–579, *Dec.*, 1938.—A study has been made of the various optical and photographic factors upon which depends the limiting magnitude which can be reached by any given telescope. The properties of the photographic plate used are of fundamental importance. Of these properties, speed is least important. A formula has been developed for the limiting magnitude which involves the contrast value, and, essentially, the graininess of the photographic plate. Values for these factors have been obtained by laboratory methods for Eastman 40 emulsion, which has been chosen as the best compromise. A large corrective term has been found which depends upon the loss of light in focal images due to scattering effects of various kinds. It has been found possible to compute this loss in any given case with considerable accuracy. Application has been made to three telescopes: the Mount Wilson 60-inch reflector, the Lick 36-inch reflector, and the Yerkes 24-inch reflector. A study has been made of the effect of pre-exposure in astronomical photography—a field in which there are many conflicting data. A laboratory study of disc images of all sizes shows an unmistakable gain with pre-exposures, a gain which is substantiated by the application of elementary photographic theory. Tests carried out with three different telescopes, however, fail to show any advantage in pre-exposure. An attempt has been made to explain this by a study of the cross-section of stellar images, computed from known optical and photographic data. It was found that the density gradient is the steepest in the case of no pre-exposure. It appears quite probable that this factor is the important one in the discrimination of threshold images. The value of the brightness of the night sky is fundamental in the problem of limiting magnitudes. A brief account is given of the work done in this field.
AUTHOR.

169. Course and Interpretation of Selective Absorption in the Region of Cassiopeia. K. Graff. *Akad. Wiss. Wien, Ber.* 147. 2*a*. 1–2. *pp.* 63–72, 1938.—The results of a visual colorimetric examination of stars in the neighbourhood of Cassiopeia revealed an exceptional number with negative colour excess [see Abstract 2764 (1938)]. It is shown that when all possible sources of error are taken into account a strict correlation can be made between colour excess and distance of the stars in question and hence that the existence of selective absorption in this region is established with certainty. The observed relation between colour excess and distance requires the assumption of a regularly distributed stratum of selectively absorbing matter reaching to the sun. The absorbing medium includes Cepheus, Cassiopeia and Camelopardalis and reaches at least up to the first giants of the h and χ Persei clusters ; it colours stars of all spectral types up to 1000 parsecs by exactly one colour class. The comparative simplicity and the reliability of the visual method of colorimetric examination of stars is stressed. J. E. K.

170. Red Indices in Galactic Clusters. Part II. J. Cuffey. *Harvard Coll. Obs., Ann.* 106. *pp.* 39–74, 1938.—[For Part I see Abstract 1042 (1938).]

171. Fe III Lines in Stellar Spectra. P. Swings and B. Edlén. *Astrophys. J.* 88. *pp.* 618–621, *Dec.*, 1938.—A term analysis of the Fe III spectrum in the u.v. region enables the writers to predict Fe III lines which fall in the astronomically observable region. Several of them are present in B-type stars, both as absorption and as emission lines. AUTHORS.

172. Recent Changes in Spectrum of Pleione. D. B. McLaughlin. *Astrophys. J.* 88. *pp.* 622–623, *Dec.*, 1938.—Spectrograms taken in Oct. and Nov. 1938, show the return of H emission in the spectrum of Pleione, after an absence of 32 years. Strong sharp absorption bisects the emission, and numerous faint sharp enhanced metallic absorption lines are present. AUTHOR.

173. Changes in Spectra of Pleiades. O. Mohler. *Astrophys. J.* 88. *p.* 623, *Dec.*, 1938.—Hydrogen emission is again present in the spectrum of Pleione (HD 23862) after an absence of 32 years. Sharp metallic absorption lines are also now present. H emission in Electra appears to have faded. AUTHOR.

174. Radiation in Turbulent Stellar Envelopes. M. Kurihara. *Kyoto Coll. Sci., Mem.* 21. *pp.* 89–143, *Sept.*, 1938. *In German.*—In the first section the author continues his work [see Abstract 1096 (1937)] on the transport of radiant energy in stellar envelopes, extending it here to a turbulent chromosphere around a Be star. The second section is devoted to considering in general terms the problem of the equilibrium of ionisation radiation, the physical condition of the envelope being characterised by 2 parameters ξ and q which determine respectively the percentage of quantum transitions from u.v. to $L\alpha$ radiation, and the transparency of the atmosphere for Balmer wave-lengths. In the third part, numerical considerations are introduced, and the dependence of q on the mean values of such physical quantities as density, temperature and absorption coefficient is investigated The particular case of a Be atmosphere is considered in detail. A. Hu.

175. Collapsed Neutron Stars. F. Zwicky. *Astrophys. J.* 88. *pp.* 522–525, *Oct.*, 1938.—Some consequences are discussed of the hypothesis that certain stars and cores of stars are composed mainly of neutrons. On the assumption that supernovæ represent rapid transitions of ordinary stars into neutron stars, the large red shifts observed in the spectra of the recent bright supernovæ are interpreted as gravitational red shifts. The neutron-star hypothesis, in conjunction with the general theory of relativity, leads to a theory of critical stellar masses. AUTHOR.

176. Interstellar Space. C. Fabry. *Roy. Astron. Soc., M.N.* 98. *pp.* 681–693, *Oct.*, 1938. *Supplement.*—The author considers all objects which are detectable in interstellar space : free electrons, atoms, molecules, corpuscles, meteorites, radiation, and cosmic rays ; and the means we have of detecting their presence : by studying absorption lines, general absorption, reflected light, bright-line excitation, collision with the earth, and celestial forces. These methods and the results to which they lead are reviewed. A. Hu.

177. Statistical Equilibrium of Stellar Clusters. H. Mineur. *Comptes Rendus*, 207. *pp*. 775–777, *Nov*. 2, 1938.—The gravitational potential of the galaxy at a point C within it being expressed as a function reduced to its first three terms, the author seeks the conditions in which a cluster of N stars, centred about C in the form of an ellipsoid of semi-axes a, b, c, may be in statistical equilibrium. It is found that $a>b>c$ and that to one value of b/a corresponds one value of b/c and one only. Close to the sun, $b/c = 1$ for $b/a = 0$ or 1, and has a maximum of $1{\cdot}375$ for $b/a = 0{\cdot}582$. The calculated dispersion of residual velocities in the cluster agrees well with that observed in the Pleiades. For Shapley's values of b/a $(0{\cdot}3<b/a<0{\cdot}95)$ and of N, the theory gives a mean value for b of $2{\cdot}4$ parsecs, a value close to that observed. A. Hu.

178. Apparent Distance to Small Star Cloud in Sagittarius. A. Wallenquist. *Arkiv f. Mat. Astron. och Fysik, Stockholm*, 26*B*. 7. [6 *pp*.], 1938. *In English*.—The small cloud in Sagittarius is at $\alpha = 18^h\ 10^m$, $\delta = -18^\circ\ 30'$, and its apparent distance is got by a spectral classification of stars on an Eastman 40 plate taken in 1931. Only white stars brighter than $M_{ph} = 11{\cdot}0$, situated in 10 square degrees round the star H.D. 167287, were used, as well as the earlier B-stars (showing no lines) and the later B-stars (with traces of lines). The spectral classification was compared with 170 common stars in the H.D. catalogue. A figure is given. Star magnitudes were based on diameters and are not very accurate. A Hertzsprung-Russell diagram is given for the intrinsically brightest stars in the cloud, and a mean value of the distance is 1340 parsecs. From apparent space densities, a distance is found, also of about 1300 parsecs. A. S. D. M.

179. Frequency of Supernovæ. F. Zwicky. *Astrophys. J.* 88. *pp*. 529–541, *Dec*., 1938.—In the period from Sept. 6, 1936, to Jan. 31, 1938, some 3,000 nebulæ brighter than apparent magnitude $m = 15$ were systematically searched for supernovæ. Each nebula appears, on the average, on about seven photographs taken at intervals spaced not closer than one month. This search is equivalent to the continuous control during one year of about 1800 nebulæ. Since three supernovæ were found in the period mentioned, it follows from our present data that the average frequency of occurrence of supernovæ is about one supernova per extra-galatic nebula per 600 years. AUTHOR.

180. Eclipsing System u Herculis. Z. Kopal. *Zeits. f. Astrophysik*, 16. 5. *pp*. 304–307, 1938. *In English*.—A discussion of spectrophotometric observations of the eclipsing system u Herculis recently made by W. Krat [see Abstract 128 (1936)]. The dependence of the ellipticity constant on the wave-length found by Krat is suggested to be an effect of the unequal form of both components. It seems that even in this classical β Lyræ-like system the brighter component is very nearly spherical, and the mean ellipticity of the system is almost completely due to the secondary. AUTHOR.

181. Absolute Dimensions of Eclipsing Variables. S. I. Gaposchkin. *Am. Phil. Soc., Proc.* 79. 3. *pp*. 327–340, 1938.—For more than 80% of eclipsing variables only the relative dimensions are known, as determined from photometric observations. Our ignorance of the masses, the result of a lack of spectroscopic observations, has been the chief handicap to a determination of absolute dimensions (radii, masses, and densities). The author has developed a formula for deriving the masses in an eclipsing system when the relative dimensions of the system and one of the spectra are known. The formula is based on the laws of motion, the law of black-body radiation, and the mass-luminosity relation (here considered empirically). The masses computed from the formula and observed directly are shown to be in agreement, with some exceptions which are discussed in detail. The observed masses are used to derive a radiation temperature scale for eclipsing stars. Finally, fifteen binary systems, of which two are spectroscopic binaries, not established eclipsing systems, are evaluated in respect to their absolute dimensions. The paper discusses some of the largest stars the radii of which have ever been derived and some of the largest masses known for eclipsing variables. Very low temperatures are involved for some of the fainter components.

AUTHOR.

See also Abstracts 184, 185, 293.

SUN.

182. Periodogram Investigation of Short-Period Sunspot Cycles. D. Alter. *Monthly Weather Rev.* 66. *pp.* 208–212, *July*, 1938.—The data for this investigation cover the period 1877–1911. A linear type of periodogram described by the author [*Annals of Mathematical Statistics*, 7. 2. *p.* 121, 1937] was used. The period investigated contains three sunspot cycles, and periodograms of 5-day means for each period have been prepared together with one for the whole of the data. As the effect of the 11-year period is troublesome in this investigation where the range of periodicities has a maximum of two years, the method of its elimination is indicated. The periodogram for each period is then examined and also that for the whole period. As a result a short period of about 65·4 days is found together with a 250-day cycle. Of these periods the shorter *appears* to vary in length and the longer to become inoperative at times, but as yet, says the author, it is impossible to be certain of changes in either.

A. E. M. G.

183. Mathematical Characteristics of Sunspot Variations. J. Q. Stewart and H. A. A. Panofsky. *Astrophys. J.* 88. *pp.* 385–407, *Nov.*, 1938.—The authors define mathematically the course of the Wolf sunspot numbers during the 16 completed cycles since 1755. The usual periodic or " superposition " point of view is rejected in favour of the " outburst " hypothesis. Each successive cycle or " outburst " is regarded as a fresh phenomenon, following, however, a standard pattern. The observed data are employed to show that the empirical form $R = F\theta^{a}e^{-b\theta}$ represents the course of spot numbers during a single cycle, R being the Wolf number, θ the interval in years after the time of beginning, s, of the outburst, and F, a and b parameters which differ for different cycles but remain constant for a single cycle. Values of these 4 parameters, s, a, b, and F, are tabulated for each cycle, and the goodness of fit is discussed. A systematic discrepancy between the time of maximum and of centroid is examined. The work suggests that the conventional periodogram analysis of spot numbers must be abandoned. Long-range prediction of spots will remain impracticable, but short-range prediction will be facilitated by the methods outlined.

A. Hu.

184. Sun's Magnitude, Stellar Temperature Scale, and Bolometric Corrections. G. P. Kuiper. *Astrophys. J.* 88. *pp.* 429–471, *Nov.*, 1938.—The quantities adopted for the sun are $Te = 5713°$ (Unsöld); and a discussion of this for O, B and A stars; $M_{pv} = 4 \cdot 73$; spectrum = *d*G2; $M_{bol.} = 4 \cdot 62$; and tables are constructed; for earlier than F_0 theoretical spectral energy-curves are used; for later, empirical bolometric corrections taken from Petitt and Nicolson's radiometric observations. Effective temperatures of late-types are derived with suitable data; Castor C (355 ± 110°) and for the giants for which the diameters (taking into account limb darkening) were measured with the interferometer there is a table given. Colour temperatures are reduced to effective temperatures and particular attention is given to observations of dwarfs; Classes A–M are shown graphically; the author asks for four desiderata in connection with the results from this paper. [See Abstract 167 (1939).]

A. S. D. M.

185. Wave-Lengths of Blended Absorption Lines. A. D. Thackeray. *Observatory,* 61. *pp.* 287–294, *Nov.*, 1938.—The centre of gravity of a close blend of two lines does not deviate seriously from the mean wave-length weighted according to oscillator strength when the lines belong to the same multiplet, or according to N*f* in other cases. St. John's solar observations [see Abstracts 936 and 937 (1913) and 2304 (1928)] of Evershed effect and vertical currents relating to blended lines (mostly within H and K) are found to confirm (*a*) the correlation of these characteristics with height and (*b*) the theoretical conception that blending raises the level of formation of Fraunhofer lines. AUTHOR.

186. Precision Wave-Lengths for Metal Hydride Bands and Evidence of Their Existence in Solar Spectrum. G. Stenvinkel, E. Svensson and E. Olsson. *Arkiv f. Mat. Astron och Fysik, Stockholm.* 26*A*. 10. [15 *pp*.], 1938. *In English.*—The authors publish the wave-lengths for the most intense bands of AlH, ZnH and CdH, corresponding to transitions to the lowest vibrational level of the ground state in emission; they give tables. They examine the claims for the presence in the solar spectrum of (1) AlH by Richardson, Swings and Nicolet, who each claim to have found it, and they find that its existence cannot be proved on available data for either disc or sunspots. For ZnH, the bands must have very low intensities if present in disc spectra, and no conclusion can be drawn. For CdH also there is no consistent evidence found in the disc. The authors also examine unsuccessfully NaH, BeH_2, CoH_3 and NiH_3, and the single doubtful case is probably CoH. A. S. D. M.

187. Solar Phenomena. R. R. McMath. *Am. Phil. Soc., Proc.* 79. 4. *pp.* 475–498, 1938.—A report of the research work of the McMath-Hulbert Observatory of the University of Michigan at Lake Angelus, Michigan, in the new field of solar studies by the motion picture method.

See also Abstract 196.

GEOPHYSICS.

GEODESY.

188. Computation of Elliptic Integrals in Special Cases. F. W. Darling. *Bull. géodésique, No.* 57. *pp.* 1–20, *Jan.–Feb.–March,* 1938. *In English.*—[See following Abstract.]

189. Formulæ and Tables for Deflection of Vertical. W. D. Lambert and F. W. Darling. *Bull. géodésique, No.* 57. *pp.* 29–71, *Jan.–Feb.–March,* 1938. *In English.*

See also Abstract 143.

HYDROSPHERE, PHYSICS OF THE.

190. Ice Formation in the Sea. J. Blüthgen. *Naturwiss.* 26. *pp.* 618–624, *Sept.* 23, 1938.—The different types of ice—polar, seashore and bay—with their differences in porosity, resistance to compression, growth and disappearance, and salt-content are described. Next the relation of climate to ice formation is considered, particularly from the distribution of land and sea, the differences in latitude, the advection of air masses of different temperatures, and the effects of currents. Differences existing over the Polar Basin and the coasts of Greenland, Scandinavia, Spitzbergen and Labrador are considered together with secular changes. Finally currents in the Baltic Sea and differences in these areas are considered.
R. S. R.

191. Structure and Circulation of the Atlantic Ocean. A. Defant. *Preuss. Akad. Wiss. Berlin, Ber.* 14. *pp.* 145–171, 1938.—The structure of the ocean is dealt with in a similar way to that of the atmosphere. An upper layer, the troposphere, is warmer and less dense, has a greater salt-content and temperature gradient, and possesses turbulent motion. The lower layer, the stratosphere, is colder and denser, has a smaller salt-content and temperature gradient, and smaller displacements. At the surface the former is present in tropical and sub-tropical regions and the latter in polar regions. An oceanic polar front exists between them. The tropospheric and stratospheric circulations are discussed in detail with reference to temperature, salt-content depth, flow, lines of convergence and divergence, displacements of the polar front and cyclonic and anticyclonic circulations. The origin of these circulations is also discussed. A series of charts shows the surface distribution of the elements and, in vertical section, the types of water and stream flow. R. S. R.

192. Tide-Gauges of U.S.A. V. Frolow. *Comptes Rendus,* 207. *pp.* 897–900, *Nov.* 14, 1938.—The changes in mean sea level recorded by tidal gauges along the Atlantic, Gulf and Pacific coasts of the U.S.A. indicate a fall in sea-level immediately south of the Canadian shield, and a rise further south, explicable as due to decreased glaciation in Canada. Those in the isthmus of Panama indicate a rise on the Pacific, a fall on the Atlantic side. Possible variations in the mean sea-level as a whole are also disdussed. C. A. S.

193. Theory of Silt Transportation by Running Water. S. Hayami. *J. Shanghai Sci. Inst. Sect.* I. 1. *pp.* 175–198, *July,* 1938. *In English.*—The suspension of small particles of running water is mainly due to the action of turbulent motion. The author has derived a differential equation which governs the suspension and transportation of small particles by turbulent motion, it being expressed by

$$\frac{\partial\theta}{\partial t} = \sum_i \frac{\partial}{\partial x_i}\left(\sum_j \eta_{ij}\frac{\partial\theta}{\partial x_j}\right) - \sum_i v_i \frac{\partial\theta}{\partial x_i} + w_0 \frac{\partial\theta}{\partial x_3},\quad i,\ j = 1,\ 2,\ 3,$$

where θ = mass of small particles of equal settling velocity in a unit volume of water; t = time; x_i = position coordinate in rectangular system, x_3 being taken vertically upward; v_i = mean velocity of water particles; w_0 = settling velocity of a small particle; η_j = turbulent tensor. The equation is solved for special cases useful in practical applications, of which scouring and silting of small particles at a river bottom by turbulent motion, and the vertical distribution of small particles in a river are perhaps the most interesting. These are discussed at some length. AUTHOR.

194. Cause of Long-Period Oscillations in Mean Sea-Level at Brest and on North Sea Coasts. J. Legrand. *Comptes Rendus*, 207. *pp*. 929–932, *Nov*. 14, 1938.—The apparent rise in mean sea-level indicated by the tide gauges at Brest, and along the North Sea coast of Holland, Germany and Denmark during the past 70–80 years is shown to coincide with rise in the mean temperature of the sea, which is suggested to be the cause. **C. A. S.**

LAND, PHYSICS OF THE.

See Abstract 193.

METEOROLOGY.

195. Structure of the Lower Stratosphere. V. Mironovitch and A. Viaut. *Comptes Rendus*, 207. *pp*. 866–869, *Nov*. 7, 1938.—Certain hypotheses concerning the structure of the tropopause are examined in the light of information gained from daily soundings of temperature. The effect of the invasion by polar air originating in latitude 50° and reaching latitude 35° is first examined, curves from actual soundings being compared with theoretical curves. Similar investigation is made in the case of invasion by tropical air with corresponding curves. The effects of such invasions are discussed, and in particular what the authors call the " doubling " (*dédoublement*) of the tropopause. This effect is very often the sign that a change of weather type is in progress. A. E. M. G.

196. Atmospheric Height Distribution of Band-Absorbed Solar Radiation. S. Chapman. *Phys. Soc., Proc.* 51. *pp*. 93–109, *Jan*. 1, 1939.—The band absorption of radiation incident on the atmosphere at any zenith angle χ is considered, when the relation between the absorption coefficient a and the wave-length λ has the form of the error function, so that $a_\lambda = a_0 e^{-(\lambda-\lambda_0)^2/\lambda^2_w} \equiv a_0 e^{-l^2}$, where $l = (\lambda - \lambda_0)/\lambda_w$, and the intensity of the incident radiation is either constant across the absorption band or varies linearly across it. The height distribution of absorbed-energy density, the height of maximum volume absorption, the spectral composition of the energy absorbed at any level, and the proportionate daily variation of absorption density, are first discussed without any special assumption as to the height distribution of the absorbing constituent in the atmosphere. The height distribution of absorbed energy per unit mass of air is shown to depend only on a single function of a single parameter μ, which itself depends on the level, the angle of incidence χ, and the total absorption coefficient A_0 of the atmosphere in the centre of the absorption band. The general results are afterwards discussed in relation to the special case of an exponential height distribution of the absorbing constituent, with scale-height H. It is shown that in this case, whatever the angle χ, (*i*) the height of maximum absorption per unit volume is at a distance $0{\cdot}616H$ below the level of maximum monochromatic absorption at the centre λ_0 of the band; (*ii*) the maximum volume density of absorbed energy at angle χ is cos χ times that for vertical incidence, as in the case of monochromatic absorption; (*iii*) above the level of maximum band absorption the height distribution of absorption differs only slightly from that in the case of monochromatic absorption, but below the maximum level the band-absorption layer extends further down than the monochromatic-absorption layer. If the absorption in the band-fringes where $|l| \gg 2$ be neglected, the band-absorption layer is thicker than the monochromatic-absorption layer by approximately $2H$, the excess thickness being in the part of the layer below the level of maximum absorption. [See also Abstract 351 (1932).] AUTHOR.

***197. Wind Velocities by Dines and Robinson Anemometers. W. A. Mattice.** *Monthly Weather Rev.* 66. *pp.* 238–240, *Aug.*, 1938.—The records here considered cover the year 1936 and are obtained from instruments at the same height and exposed under similar conditions. The methods employed in making comparison between the two instruments are described. Two figures show the relationships obtained, one the relation between average gust velocities on the Dines and the fastest single mile in the Robinson, the other that between the extreme gust velocity and the fastest single mile. These enable a factor to be found which when applied to the Robinson record reduces it to the Dines. The effect of the inertia of the cup anemometer is also investigated for velocities of different magnitudes. A. E. M. G.

198. Geostrophic, Surface and Upper Winds at Valentia. L. H. G. Dines. *Meteorolog. Office, Prof. Notes, No.* 83. [12 *pp.*], 1938.—This investigation deals with the period 1917–21, the data being obtained from the readings of the Dines anemometer, the daily synoptic charts and from pilot balloon observations. The ratios of the surface wind W to the geostrophic wind G, have been determined and grouped according to both direction and velocity. Two methods of investigations are used. These are described and the results of the investigations given in tabular form. The differences arising from the two methods are discussed. As supplementary to the above the pilot balloon soundings over the same period are analysed. From the investigation it is concluded that the ratio W/G for Valentia gives results difficult to understand. The author gives a summary of his main conclusions regarding W/G and the heights at which the direction and velocity of the geostrophic wind are reached. A. E. M. G.

See also Abstracts 86, 190.

SEISMOLOGY.

199. Earthquake Shocks with Local Origin. Shocks at Cansiglio in October, 1936. XIV. P. Caloi. *Ricerca Scientifica*, 2. *pp.* 408–446, *Oct.*, 1938.—This is a contribution to the study of the characteristic seismic disturbances of N.E. Italy. Determinations are given of the epicentre and the hypocentral depth of the strong shock of Cansiglio on Oct. 18th, 1936, together with data of 39 European and Asiatic stations. Determinations of the course of the most notable phases are given. The velocity is compared with the results of observers in Central Europe. The existence of two new phases is proved. Details are given of the thickness of the strata affected. The direction of the movement of the crust on the surface is considered. Evidence is given that the principal shock was due to a fracture caused at a depth of about 17 km. by a pair of inclined forces. J. J. S.

TERRESTRIAL ELECTRICITY AND MAGNETISM.

200. Atmospheric Electric Field at Sea. J. Rouch. *Comptes Rendus*, 207. *pp.* 678–679, *Oct.* 17, 1938.—Thirty observations were made on board ship in Aug. and Sept., 1938, in the Atlantic and the Mediterranean.

A description of the apparatus used was given in the records of the Second French Antarctic Expedition (Paris 1913). The principal results of the observations are: On the Atlantic the field is from 100–130 V/m. This increases on passing through the Straits of Gibraltar to about 210 V/m., then falls to rise again between Sicily and Tunis. Further east it falls again to about 140 V/m. Higher values are recorded in the afternoon than in the morning. A. E. M. G.

201. Progressive Lightning. Part VI. B. F. J. Schonland, D. J. Malan and H. Collens. *Roy. Soc., Proc.* 168*A*. *pp*. 455–468, *Nov.* 25, 1938.—An account is given of some apparently anomalous lightning discharges observed with the Boys camera, and it is shown that their behaviour is in accordance with the same principles as govern the more usual type of discharge. Certain abnormal first leader processes occur in two stages, the first rapid and the second involving a velocity close to the limiting value for negative streamer propagation. The first stage is considered to arise from the presence of space-charge concentrations in the air below the cloud. Dart streamers may travel down from the cloud during the second slow stage and catch up with the leader tip. Changes in the lower portions of the channels used by successive strokes of the same flash are shown to be associated with long time intervals between strokes, whereby the conductivity and guiding power of the previous track is destroyed. A case of change in the upper portion of the channel is ascribed to the existence of a second centre of charge within the cloud. [For Part V see Abstract 2383 (1938).] AUTHORS.

See also Abstract 374.

RADIOACTIVITY.

202. Determination by Wilson Method of Nature and Energy of Particles Emitted in Transmutations. F. Joliot and I. Zlotowski. *J. de Physique et le Radium*, 9. *pp*. 393–402, *Oct.*, 1938.—The apparatus, method of experimenting (with field of 16000 gauss) and of deducing results are described in detail. Applied to the above reaction $^{10}_{5}\mathrm{B}(\alpha, p)^{13}_{6}\mathrm{C}$, the α-particles being derived from a source of Po of about 80 m.c., the result of photographing 956 trajectories and of measuring 270 is that $^{13}_{6}\mathrm{C} + ^{1}_{1}\mathrm{H} + Q$ is formed. One group of protons with $Q = 4{\cdot}4 \times 10$ eV was found. The maximum energy of the protons observed was 9×10^6 eV, and the corresponding group extends (on account of geometrical conditions) to $7{\cdot}5 \times 10^6$ eV. None were observed between 7·5 and $6{\cdot}5 \times 10^6$ eV, and there is probably no group with $Q = 3{\cdot}1 \times 10^6$ eV, but two with $Q = 4{\cdot}3$ and $2{\cdot}0 \pm 0{\cdot}3 \times 10^6$ eV of approximately equal intensity. Of the trajectories measured four were definitely due neither to protons nor helions, but corresponded with trajectories of deuterons, possibly due to $^{10}_{5}\mathrm{B} + ^{4}_{2}\mathrm{He} \rightarrow ^{12}_{6}\mathrm{C} + ^{2}_{1}\mathrm{H}$. C. A. S.

203. Formation of $^{5}_{2}$He by Collisions between Helions and Deuterons. F. Joliot and I. Zlotowski. *J. de Physique et le Radium*, 9. *pp*, 403–410, *Oct.*, 1938.—A detailed account of the experiments and arguments leading to results previously reported. [See Abstract 2825 (1938).] C. A. S.

204. Discrete Groups of Particles Emitted in Disintegration of Nitrogen by Rapid Neutrons. J. Thibaud and P. Comparat. *Comptes Rendus*, 207. *pp*. 851–853, *Nov*. 7, 1938.—Further examination of the reaction [see Abstract 4055 (1938)] ${}^{14}_{7}N + {}^{1}_{0}n$ (rapid) → ${}^{11}_{5}B + {}^{4}_{2}\alpha$ has disclosed groups of energies 0·65 and 0·75 × 10^6 eV, and shown that the abnormally large group reported as of energy 1·30 × 10^6 eV consists really of two groups of 1·25 and 1·42 × 10^6 eV, so agreeing with the results of Wilhelmy [see Abstract 602 (1938)]. Though all the groups are probably α-particles the possibility of some being protons formed according to ${}^{14}_{7}N + {}^{1}_{0}n \rightarrow {}^{14}_{6}C + {}^{1}_{1}H$ is not absolutely excluded. In any case they are not produced by slow neutrons stopped by Cd. C. A. S.

205. Period and Absorption of β-Rays from Radiophosphorus P^{32}_{15}. P. C. Capron. *Physica*, 5. *pp*. 882–888, *Oct*., 1938. *In French*.—Radiophosphorus P^{32}_{15} was extracted from specimens of CS_2 irradiated by by neutrons from a Rn-Be source, and the half-life period determined by means of a Geiger counter adapted for the measurement of β-rays. The value obtained was 14·5 ± 0·3 days. Determinations were also made of the absorption of the β-rays in Al. Complete absorption was found at 2·85 ± 0·05 mm. Al, giving, on the basis of the formula of Feather, the limiting value of the energy of the β-rays from P^{32}_{15} as 1·68 ± 0·05 eMV. No evidence was obtained either to confirm or disprove the existence of a radiosulphur ($S^{34}_{16} + n^{1}_{0} \rightarrow S^{35}_{16}$), as suggested by Gueben. J. E. R.

206. Radioelements Formed by the Action of Neutrons on Uranium. Part II. I. Curie and P. Savitch. *J. de Physique et le Radium*, 9. *pp*. 355–359, *Sept*., 1938.—The radioelement previously described [see Abstract 5143 (1937)] of period 3·5 hr. found by irradiating U with neutrons is discussed. It is chemically similar to La. Its atomic number is undecided, but it is probably an isotope or isomer of U, with, however, a different electron configuration, leading to a different valency. H. G. C.

207. Neutron-Induced β-Radiation from U. I. Curie, P. Savitch and A. M. da Silva. *J. de Physique et le Radium*, 9. *p*. 440, *Oct*., 1938.—By means of a Wilson chamber with a magnetic field, an investigation has been made of the β-spectrum from U on bombardment with neutrons. The energy limit of the β-spectrum is found to be approximately 3·2 eMV, while the maximum lies between 0·75 and 1 eMV. G. O. B.

208. Neutron-Induced Ra Isotopes from U. O. Hahn and F. Strassmann. *Naturwiss*. 26. *pp*. 755–756, *Nov*. 18, 1938.—Two principal types of process have been detected on the irradiation of U^{238}_{92} with neutrons. In the first group three U isotopes are formed which in their turn form seven trans-U atoms with the atomic numbers 93 to 96. In the second process, two successive losses of α-particles yield ${}^{231}_{88}Ra$ which can disintegrate by β-particle emission in three ways through ${}_{89}Ac$ to give ${}_{90}Th$. Thus by irradiation of U by neutrons, 16 kinds of atoms can be formed artificially with atomic numbers between 88 and 90 and 92 to 96. G. O. B.

209. Radioactive Isotopes of Iodine. J. J. Livingood and G. T. Seaborg. *Phys. Rev*. 54. *pp*. 775–782, *Nov*. 15, 1938.—Five radioactive iodine isotopes are described, three of which are new. These were produced, by use of 8 eMV deuterons, 16 eMV helium ions and neutrons. Evidence is presented for the following isotopic assignments and properties:

Reaction	Half-Life	Particle Range gm./cm^2. Al	Gamma—Half-Thickness gm./cm^2. Pb
$I^{127}(n, \gamma)I^{128}$	25±1 min. (−)	1·05	3·5
$Te^{128}(d, 2n)I^{128}$			
$I^{127}(n, 2n)I^{126}$	13·0±0·3 days (−)	0·44	4·5
$Sb^{123}(\alpha, n)I^{126}$			
$Te^{125}(d, n)I^{126}$			
$Sb^{121}(\alpha, n)I^{124}$	4·0±0·3 days (+)	—	—
$Te^{128 \text{ or } 130}(d, n)$ $I^{129 \text{ or } 131}$	8·0±0·2 days (−)	0·50	3·3
$Te^{130}(d, 2n)I^{130}$	12·6±1·0 hr. (−)	0·40	6·0

It is shown that the 8-day activity is also produced by the radioactive decay of $Te^{129 \text{ or } 131}$. Chemical identification has been made in every case. A table of approximate yields is given. AUTHORS.

210. Nuclear Isomerism. N. Feather and J. V. Dunworth. *Roy. Soc., Proc.* 168*A. pp.* 566–585, *Nov.* 25, 1938.—The application of the method of coincidence counting by electrical means to the study of the time-correlation of nuclear processes—particularly that of successive quantum emission—is discussed in detail. It is shown that a knowledge of the energy dependence of the sensitivity of the counters is essential for any interpretation of the results of such experiments. For the γ-ray counters employed in the present investigation some information on this point has been obtained by the use of sources of Th active deposit of short and long exposure. In the course of this work the general validity of the ideas of Ellis and Mott (1933) and of the nuclear level schemes of Oppenheimer (1936) has been established. Also the paired quanta of the annihilation radiation of positrons have been utilised in the calibration. A study of the γ-radiations from UZ and the long-lived modification of Ag^{106} by the coincidence method has shown, in the former case, the emission of two quanta in succession in a very large fraction of the disintegrations, and, in the latter, the emission of 4 or 5 quanta in succession in the most probable mode. This result is in general accord with the view that nuclear isomers are to be distinguished one from the other by a small difference in energy content and a large difference in angular momentum. The particle emission from the short- and long-lived modifications of Ag^{106} has also been studied. It appears probable that the negative electrons of the long-period activity are internal conversion electrons associated with nuclear transitions following electron capture, rather than that they represent a distinct mode of disintegration of the long-lived radio element, Ag^{106}. [See also Abstract 1949 (1938).] AUTHORS.

211. Grain-Spacing of α-Ray, Proton and Deuteron Tracks in Photographic Emulsions. T. R. Wilkins and H. J. St. Helens. *Phys. Rev.* 54. *pp.* 783–788, *Nov.* 15, 1938.—A statistical study has been made of the grain-spacing of α-ray, deuteron and proton tracks in an Ilford *R* 2 emulsion with standardised processing and viewing technique. The α-rays were from ThC and ThC′ and the deuterons and protons from cyclotrons. A theoretical explanation of the difference in grain-spacing is given and some applications of the technique in the study of cosmic rays and nuclear research. AUTHORS.

212. α-Particle Reactions in CO, O_2 and CO_2 Systems. J. O. Hirschfelder and H. S. Taylor. *J. Chem. Phys.* 6. *pp.* 783–790, *Dec.*, 1938.—The methods developed by Eyring, Hirschfelder and Taylor [see [illegible] 4119 (1936)] for the analysis of the α-particle reactions in H_2 [illegible] Br_2 systems have been extended to the corresponding reactions [illegible] O_2 and CO_2 systems and to mixtures of these gases. It has been shown that experimentally known processes of ionisation and of excitation, together with the probable neutralisation processes, with consequent chemical reactions involving the atomic species so produced, suffice to account quantitatively for the observed experimental results. This extends the scope of the method employed to typical α-particle reactions of decomposition, ozonisation and oxidation hitherto interpreted in terms of a clustering mechanism. AUTHORS.

213. β-Ray Spectrum of Ra-E. Y. Watase and J. Itoh. *Phys. Math. Soc. Japan, Proc.* 20. *pp.* 809–813, *Oct.*, 1938. *In English*.—The β-ray spectrum of Ra-E was measured by the magnetic focusing method and it was found that the general shape of the spectrum agreed with the theory of Konopinski and Uhlenbeck, while, near the upper limit, the experimental points fall appreciably below the K.-U. curve. Thus the neutrino mass must not be assumed to be zero, but about 0·4 of the electron mass. The extrapolated K.-U. upper limit was $3{\cdot}67mc^2$, while the inspection upper limit was $3{\cdot}27mc^2$. [See also Abstract 4458 (1938).] AUTHORS.

214. Relation Between Range and Energy for Upper Limits of β-Ray Spectra. E. E. Widdowson. *Phys. Soc., Proc.* 51. *pp.* 19–25, *Jan.* 1, 1939.—The linear relation $R = 0{\cdot}460E_K - 0{\cdot}226$, connecting the maximum range R in gm./cm.^{2} with the Konopinski-Uhlenbeck upper limit E_K in MV for continuous β-ray spectra, is obtained from experimental results; and those results which show large deviations from it are discussed. The {range, energy} relation for electrons in Pb, Al and air is obtained from quantum-mechanical formulæ, and is found to be linear in the region under consideration. Reasons for the differences between the theoretical and empirical relations are suggested. AUTHOR.

215. γ-Radiation from Ac. S. P. Choong and J. Surugue. *J. de Physique et le Radium*, 9. *pp.* 437–439, *Oct.*, 1938.—Using an apparatus described elsewhere [see Abstract 610 (1938)] a study has been made of the secondary β-spectrum from active deposits of Ac in an attempt to detect β-rays of very feeble intensity. Several new rays have been discovered. The results are given in tabular form. Some of the new rays have permitted the establishment of a scheme of energy levels which is satisfactory for the transformation AcB→AcC with three new γ-radiations. For the transformation AcC→AcC″ a single new γ-radiation is indicated, which is, however, doubtful. In an additional note Surugue claims that some new experimental results on the γ-radiation from U, by other workers, permit of a correct interpretation of two rays in the earlier paper. G. O. B.

216. Measurement of γ-Radiation of High Frequency by Means of Materialisation Pairs. C. Magnan. *Comptes Rendus*, 207. *pp.* 857–859, *Nov.* 7, 1938.—In view of the disagreement between the results previously obtained [see Abstract 598 (1938)], and the theoretical deductions of Bethe and Heitler [see Abstract 3411 (1934)] the possible effect of the geometrical form of the spectrograph was examined as regards the materialisation pairs resulting from the γ-ray ($h\nu = 2{\cdot}62 \times 10^6$ eV) produced in ThC″→ThD. C. A. S.

217. Excitation of γ-Radiation in Processes of Proton Capture by Light Elements. S. C. Curran, P. I. Dee and V. Petržilka. *Roy. Soc., Proc.,* 169*A*. *pp*. 269–289, *Dec*. 22, 1938.—Using a pair of Geiger-Müller counters in coincidence the excitation functions for the γ-radiations emitted in the process of proton capture by each of the elements, Be, B, C and F have been determined for energies of the incident protons from 0 to 10^6 eV. Resonance peaks have been found in the excitation curves for incident protons of the energies given below: Be: 350, 670 × 10^3 eV; B: 180, 650, 850, 950 × 10^3 eV; ^{12}C: 480 × 10^3 eV; ^{13}C: 570 × 10^3 eV; F: 330, 470, 590, 670, 860, 920 × 10^3 eV. Several of these resonance peaks had not hitherto been discovered. In the cases of Be and B a continuous excitation of γ-radiation over the whole of the region of voltage employed was observed, and evidence is presented in support of the view that this radiation must be associated with the capture process. The yield of γ-radiation was measured in the case of C, the values obtained being $2{\cdot}5 \times 10^{-10}$ quanta/proton for ^{12}C and $6{\cdot}2 \times 10^{-9}$ quanta/proton for ^{13}C. A calibration curve is given relating the end-points of the coincidence absorption curves (obtained by placing Al between the counters) with the maximum quantum energies of the incident γ-radiations. A search for the production of radioactive ^{11}C as a result of the capture of protons by B has shown that the cross-section for this effect is at least 100 times smaller than the value which has been reported by other workers. AUTHORS.

***218. Vacuum H.V. Generator. H. Alfvén and S. Eklund.** *Arkiv f. Mat. Astron. och Fysik, Stockholm,* 26*B*. 5. [4 *pp*.], 1938. *In English*.—The adaptation of the voltage multiplying circuit used by Cockcroft and Walton [see Abstract 4364 (1932)] for use in a vacuum to permit a reduction in the size of the apparatus is discussed. A two-stage generator is described in which a 50-cycle supply voltage of 90–95 kV crest is stepped up to give d.c. of twice this value. The condensers, filaments for the rectifiers, etc., are housed in an evacuated metallic cylindrical box of 30 cm. dia. and 20 cm. high, into which the a.c. supply is carried *via* a bushing insulator. The capacitance of the condenser which takes the output voltage is 30 cm. so that a load current of 20 μA results in a variation of 10% in the delivered voltage. R. D.

***219. H.V. Generation with the Aid of Condensers. V. I. Likhoff, V. I. Pavloff.** *Comptes Rendus* (*Doklady*) *de l'Acad. des Sciences, U.S.S.R.* 20. 2–3. *pp*. 121–124, 1938. *In French*.—Most h.v. generations produce either currents of short duration, or of small magnitude. A generator is described which will deliver appreciable currents (60 mA). It consists of a central pile of condensers in the middle of a disc which rotates. A series of isolated auxiliary condensers is located round the periphery of the disc. As this rotates the auxiliary condensers in turn are charged from a direct voltage source and connected to each section of the condenser pile in order starting from the bottom of the pile. The voltage of the central pile is built up in this way to a value *n*V at the top where n is the number of sections and V the voltage applied to each auxiliary condenser. Electrolytic condensers are used, and details of their arrangement in the equipment, and of the necessary commutator system are given. An estimated output of 60 kW at 10^6 V is suggested from a generator occupying a small base, and a model delivering 100 kV from a 7 kV source is described. R. D.

***220. Counting Effect of Tubes with Plane Parallel Electrodes. B. Kwal.** *Comptes Rendus*, 207. *pp.* 724–726, *Oct.* 24, 1938.—By using two tubes filled with H_2 and fitted with plane parallel electrodes it is shown that such tubes may be used as counting devices. Flashing occurs only when the ionising agent passes through a certain region close to the edge of the electrodes. F. C. C.

***221. Use of Ordinary Counters for Counting Rapidly Occurring Phenomena. B. Kwal and M. Lesage.** *Comptes Rendus*, 207. *pp.* 779–780, *Nov.* 2, 1938.—In impulse counters of the Geiger-Müller type, one is limited by the inertia of the mechanical counter. Various devices, more or less complicated, have been described for overcoming this difficulty [see Abstract 4064 (1938)]. An essentially simpler method is here described for achieving the same result. It consists in interrupting periodically, by electrical or mechanical means, the counter circuit, in such a way that during a fraction of the period, greater than the dead time of the counter, the latter is out of circuit, while during the remainder of the period it receives practically maximum impulse. Under these conditions it is shown that the indications of the counter must be multiplied by ρ, the ratio of the period of the rotating contact to the time during which the counter circuit remains closed. A. W.

***222. Geiger Counter for β-Rays. A. K. Brewer and A. Bramley.** *J. of Applied Physics*, 9. *pp.* 778–784, *Dec.*, 1938.—A Geiger counter for β-rays is described that is easy to construct and has the low background count of 2 per min. Two modifications are in use, one in which the rays are admitted through an Al foil supported by a Cu grid; and the other in which the material to be tested is placed directly within the chamber. The characteristics of various gases are discussed; it is shown that while organic vapours tend to lower the background count they also lower the sensitivity. A simple method for measuring the counter efficiency for rays of different energies is outlined. AUTHORS.

***223. Extinction of Discharges in Geiger-Müller Counters. A. N. May.** *Phys. Soc., Proc.* 51. *pp.* 26–32, *Jan.* 1, 1939.—The discharge in Geiger-Müller counters is discussed in terms of the Townsend theory. It consists of a series of electron avalanches, each avalanche being generated from photoelectrons ejected from the outer wall by the previous avalanche. At low currents the average number of photoelectrons per avalanche is small, and if the actual number for some avalanche happens to be zero, the discharge will stop. This accounts for the extinction of the discharge at low currents. The theory gives an exponential decay formula for the probability of the discharge lasting a given time, and the mean life-time increases exponentially with the current. This is in accord with Werner's experiments, and his numerical values are in good agreement with the theory. AUTHOR.

See also Abstracts 2, 148, 418, 419, 421, 431, 433.

RADIATION.

ABSORPTION.

224. Indications of Permanganate Ions in Violet and Red Apatites. J. Hoffmann. *Akad. Wiss. Wien, Ber.* 147. 2*a*. 3–4. *pp.*

121–126, 1938.—Reasons are given for supposing that coloured apatite owes its colour to permanganate ions. J. E.

COLORIMETRY.

See Abstracts 262, 263, 264, 265, 328.

ELECTRO-OPTICAL AND MAGNETO-OPTICAL EFFECTS.

225. Temperature Dependence of Electric and Magnetic Birefringence of Liquids. K. H. Grodde. *Phys. Zeits.* 39. *pp.* 772–783, *Nov.* 15, 1938.—The simple orientation theory, valid for gases, cannot be applied to the electric birefringence of liquids, since it assumes complete disorder of molecular arrangement, and the internal field, being anisotropic, is no longer the Lorentz-Lorenz field ; but the results are approximately correct for magnetic birefringence, when the effects neglected are very small. Comparison of the temperature dependences of the two effects should make it possible to determine the internal field more accurately and to assess the degree of orderliness in the liquid. Measurements are described for 12 liquids. The effect in the magnetic case is much larger than expected, and varies from a proportionality to less than 1/T for non-polar liquids to one larger than 1/T as the electric moment increases. The Cotton-Mouton constants of some liquids are higher than those of their vapours. These effects cannot be explained in terms of the temperature variation of magnetic susceptibility and are attributed to orderliness in the molecular arrangement in liquids. C. B. A.

226. Paramagnetic Rotatory Power and Magnetisation of Ce$^{\cdots}$ in the Hydrated Ethylsulphate. J. Becquerel, W. J. de Haas and J. van den Handel. *K. Onnes Lab., Leiden, Comm. No.* 244*e*. *Physica*, 5. *pp.* 857–869, *Oct.*, 1938. *In French.*—The law which expresses the paramagnetic rotation of the hydrated ethylsulphates of Dy, Er, Pr and Nd at the temperature of liquid He [see Abstract 4073 (1938)] is not obeyed by Ce at 1·37° K nor at the temperature of liquid He. The Ce$^{\cdots}$ ion contains only one magnetogenic electron, and the fundamental level of the free ion must be split up by the applied field into only three levels, two of which are very near together. The curve of the susceptibility against the temperature is, between the temperature of liquid ethylene and room-temperature, approximately parallel to that corresponding to the free ion ; but this parallelism is not obtained for the curve involving $\chi_{||}$ parallel to the optical axis. The third energy level is thus probably far removed from the other two. W. R. A.

***227. Magneto-Optical Measurement of Intense Direct Currents. A. Cotton.** *Comptes Rendus*, 207. *pp.* 820–822, *Nov.* 7, 1938.—A method is briefly described for measuring intense currents by utilising the magnetic rotatory power of certain liquids. The current is passed round a conductor of symmetrical shape and the sum of the rotations measured on each side in turn is given by $\rho = 4\pi i \times R$, where R is Verdet's constant and i is in absolute units. The accuracy obtainable by the method is high provided the current is intense enough to give a measurable rotation. H. J. H. S.

See also Abstract 277.

EMISSION.

228. Internal Stresses and Dynamics of Radiating Electron. T. de Donder and J. Géhéniau. *Comptes Rendus*, 207. *pp.* 719–722, *Oct.* 24. 1938.—It is shown how to define the internal stresses of an electron in order to deduce the laws of dynamics for a radiating electron obtained recently by Dirac [see Abstract 3660 (1938)]. G. C. McV.

229. Photons and Pair Production. M. Markov. *Comptes Rendus (Doklady) de l'Acad. des Sciences, U.S.S.R.* 20. 2–3. *pp.* 125–127, 1938. *In English.*—In analysing the inelastic scattering of a photon about a nucleus with pair production, it is shown that the ratio of the cross-sections for processes of the third and second orders, is independent of the energy for large energies. G. O'. B.

***230. Positive Electrode of Carbon Arc in Air as Standard Lamp. C. Krygsman.** *Physica,* 5. *pp.* 918–928, *Dec.,* 1938. *In English.*—The emission of the positive electrode of a carbon arc in air is calibrated. It turns out to be the same as the emission of a black body of a temperature of about 3800° K.; in the u.v. the continuous emission of the gas of the arc is superposed on the positive-electrode emission. AUTHOR.

231. Temperature Variation of A.C.-Heated Tungsten Filaments. W. Elenbaas. *Physica,* 5. *pp.* 929–937, *Dec.,* 1938. *In German.*—The temperature of the filament of a glow-lamp when operated with a.c. is calculated. At the same effective voltage the mean temperature with a.c. is somewhat lower than on d.c. (for a 10 μ filament at a mean temperature of 2500° K. this difference is about 4·5° C.). The difference in evaporation and light output at a.c. and d.c. of the same effective voltage is calculated and compared with the measured difference in life and light output. In order to be independent of unequal effective voltages on a.c. and d.c., lamps with 35 μ filaments, which show only little difference, are used as comparison lamps, which are operated at the same time on the same voltage with the 10 μ filament lamps. The agreement between calculated and measured difference (life 50–60% more and light output 2–3% less on d.c. as compared with a.c. for a 10 μ filament at 2500° K.) is good. AUTHOR.

***232. Integrator of Radiant Energy. L. Quevron.** *Comptes Rendus,* 207. *pp.* 902–903, *Nov.* 14, 1938.—A description is given of a device which measures the total amount of radiation received by it in a given time. It consists of a photo-cell, or thermopile, coupled to a fluxmeter. It is shown that the total deflection of the fluxmeter in a given time is proportional to the radiant energy received during that period. D. H. F.

233. Quantum Theory and Origin of Cosmic-Ray Showers. G. Wataghin. *Accad. Lincei, Atti,* 27. *pp.* 675–678, *June* 19, 1938.—The author tries to find a new basis for the quantum theoretical treatment of cosmic-ray showers by assuming that a new indeterminacy exists in the impulse space for all impulses greater than a critical value b. It shall be impossible to distinguish experimentally between the eigenfunctions of f.i. stationary electronic waves in an enclosed space b and $n(p)$ neighbouring states. The eigenfunction of a plane wave ψ is in this representation a linear combination of the eigenfunctions $\phi(p,x)$ of the usual quantum theory: $\psi(p', x) = \int_k G'(p, k)\phi(k, x)dk$, where $G'(p', k)$ is for example

$$G'(p', k) = Ae^{-\frac{(p'-k)^2-(E'_p-Ek)^2\frac{1}{C^2}}{ab\Delta p}}.$$

A, a are constants, b is the critical impulse, and the interval Δp satisfies the relation $(8\pi/c^3)VG(p')p^2\Delta p = n(p)$; $p = |p'|$. For $p' < b$, the new states ψ are orthogonal, but for $p' > b$ there is no orthogonality. New rules for the commutability can be derived for the finite matrices P with elements $P_{mn} = (\psi_m, p\psi_n)$. $m, n = 1 \ldots N$, where N is the number of states in the impulse space. As the quantum states are no larger orthogonal, processes of emission of many particles (explosion-showers) are to be expected as the rules applying to the orthogonality and other properties of the eigenfunctions of the harmonic oscillator are no longer valid. The probability that many particles are emitted will be of the same order as the probability for the emission of one particle. L. K.

234. Registration of Intensity of Cosmic Rays. G. Bernardini. *Ricerca Scientifica*, 2. *pp.* 397–407, *Oct.*, 1938.—A preliminary account is given of a new arrangement for the systematic registration of cosmic rays which consists essentially of the measurement and recording of triple coincidences by means of Geiger counters. J. J. S.

235. Ionisation by Cosmic Rays. S. Szczeniowski, S. Ziemecki and K. Narkiewicz-Jodko. *Acad. Polanaise Sci. et Lettres, Bull.* 6–7*A*. *pp.* 273–289, *June–July*, 1938. *In English.*—Experiments were carried out to investigate whether the law that ionisation by cosmic rays is proportional to the density of the gases through which they pass is valid in the upper layers of the troposphere. The pressure chambers used were steel spheres of about 900 cm^3. capacity. They were connected with Lindemann electrometers. Observations were made in a balloon near Warsaw on a windless day at heights between 6000 and 10,000 m., the pressures varying from 380 to 207 mm.Hg. The measurements were made with a N_2 ionisation chamber and then with a Kr chamber. The simple law of proportionality between ionisation by cosmic rays and gas density was found. At the heights where the measurements were made the soft-component of cosmic rays strongly prevails. The data obtained show that, contrary to the results of Juilfs and Masuch, the mechanism of the ionisation is the same for particles of the hard and soft components of the cosmic rays. Ionisation by γ-rays is subject to laws markedly different from those for cosmic rays. The ionisation curve obtained by the authors is much steeper than that of Kolhörster. No discontinuities were found in their observations and thus they conclude that in the atmosphere there exist no radioactive bodies of terrestrial or extra-terrestrial origin. J. J. S.

236. Penetrating Component of Cosmic Rays. P. M. S. Blackett. *Nature*, 142. *pp.* 692–693, *Oct.* 15, 1938. *Paper read before the British Assoc., Aug.*, 1938.—An outline is given of the evidence leading to the identification of the penetrating component of the cosmic radiation with a particle intermediate in mass between that of the electron and that of the proton. Yukawa's theory of the short-range nuclear forces, in which the existence of these particles is predicted, is sketched. It is shown how the theoretically predicted instability of these particles can account for the failure of the mass-absorption law for the penetrating cosmic rays in air and in dense materials. D. H. F.

237. Penetrating Component of Cosmic Rays and its Associated Bursts. H. Euler. *Zeits. f. Physik*, 110. 11–12. *pp.* 692–716, 1938.—It is assumed that the penetrating component of the cosmic radiation consists of the particles predicted by Yukawa, and that the soft component originates largely from the theoretically predicted decay of these particles: the experimentally observed proportions of the hard and soft components then lead to a value for the decay period of the Yukawa particles of the same order as that calculated from β-ray disintegrations; and to a calculated mean energy loss for the cosmic-ray particles, as a function of their energy, in agreement with the experimental results of Blackett. It is shown that it is probable that the penetrating component is responsible for non-cascade Hoffmann bursts. On the assumption that the process by which these bursts are produced is a nuclear explosion, and that heavy electrons predominate in them, the mean energy of the secondary particles is calculated, and also the mean cross-section for their production.

D. H. F.

238. Large Cosmic-Ray Showers at 2800m. Altitude. P. Auger and R. Maze. *Comptes Rendus*, 207. *pp*. 671–674, *Oct*. 17, 1938.—The experiments on large showers, carried out at sea-level with widely separated counters [see Abstract 4083 (1938)], were continued at 2800m. altitude. The number of these showers was found to be several times greater than at sea-level, and the variation of the frequency of their occurrence with increasing separation of the counters was studied. The penetrating power of the shower particles was studied, for several separations, and it is concluded that a proportion of the particles are of the penetrating type. It is found that, as at sea-level, the density of the particles is about 25–30 per m^2. and that the total number in a shower is greater than 10^4. The total energy of these showers is considered to be probably greater than that previously reported at sea-level (10^{12}–10^{13}eV). [See following Abstract.] D. H. F.

239. Large Cosmic-Ray Showers at 3500 m. P. Auger. *Comptes Rendus*, 207. *pp*. 907–910, *Nov*. 14, 1938.—It was found that with counters separated by 4m. the shower-frequency was considerably greater at 3500m. than at 2800m. [see preceding Abstract], the increase being greater than that in the ordinary showers. The density of the rays was about 50/sq.m. The absorption of the shower particles was studied, and some were found capable of penetrating 18cm. of Pb. Evidence is adduced that the penetrating component of the showers may be itself shower-producing. Counter-controlled Wilson cloud-chamber photographs of the showers were obtained. A considerable proportion of the exposures (6 out of 48) show tracks of heavily ionising particles, indicating the presence in the showers of rays capable of strong nuclear interactions. It is concluded that the showers are cascade showers initiated by electrons of very high energy ($> 10^{13}$ eV), and contain a component capable of traversing 10 cm. of Pb. D. H. F.

240. Angular Spread of Hard Cosmic-Ray Showers. G. Wentzel. *Phys. Rev.* 54. *pp*. 869–872, *Dec*. 1, 1938.—In order to account for the experimental results of Schmeiser and Bothe [see Abstract 2423 (1938)] the " dynaton " theory has to be modified by the introduction of a " form-factor " which reduces the probability of showers with large angular divergence. A particular invariant " cutting off " rule is discussed.

AUTHOR.

241. Theory of Energy Losses of High-Energy Particles. L. W. Nordheim. *Frank. Inst., J.* 226. *pp*. 575–597 ; *Disc.*, 598–600, *Nov.*, 1938.—Report on the present position with regard to the energy losses of high-energy particles. It is considered that electro-magnetic theory is quite sufficient to explain the major part of all cosmic-ray phenomena, provided the soft component is identified with electrons and positrons, and the hard component with barytrons (mesotrons). The questions which remain yet unsolved concern the origin of the hard rays and their secondary effects. Yukawa's suggestion of linking the properties of mesotrons with nuclear forces offers hope of explaining certain non-electric effects. In the Discussion, **W. F. G. Swann** raises the question of the validity of the application of Gross analysis at high altitudes, and comments on the mechanism by which energy losses take place for large impact parameters. F. C. C.

242. Disintegration of Mesotrons. P. Ehrenfest, Jr. and A. Fréon. *Comptes Rendus*, 207. *pp.* 853–855, *Nov.* 7, 1938.—Experiments (determination of intensity as a function of zenith angle), carried out on the Jungfraujoch (3450 m.) are described to test Heisenberg's explanation that the fact that the intensity of vertical penetrating cosmic radiation as measured at sea-level is greater than that of similar radiation measured at some altitude in a direction so inclined to the vertical that the radiation passes through an equal mass of air, is due to spontaneous disintegration of the mesotrons in their longer (in time) passage through air. Possible reasons for the disagreement between the inferences drawn from the results and those deduced from Yukawa's theory [see Abstract 3000 (1938)] are discussed. C. A. S.

243. Theory of Coincidence Experiments on Cosmic Rays. N. Arley. *Roy. Soc., Proc.* 168*A. pp.* 519–545, *Nov.* 25, 1938.—Further calculations are made on the cascade theory of showers put forward by Bhabha and Heitler and by Carlson and Oppenheimer [see Abstracts 2076 and 1632 (1937)]. The number of "slow" electrons in a shower is calculated, i.e. of electrons having an energy less than the critical energy of the shower-producing material. The fluctuations of the number of particles about the mean number are discussed. By means of a simplified model for the multiplication process it is made plausible that the Poisson formula holds for the fluctuation in small showers. The energy spectrum of the soft component is discussed. With this energy spectrum the mean probabilities of finding one, two or more particles emerging from a certain layer are calculated, giving the absorption curve and the Rossi transition curves. Results are compared with experiments. The quantitative agreement between theory and experiment for the absorption and the Rossi curves is very satisfactory both with regard to the shape of the curves and their dependence on the material. There is, however, a difficulty in understanding the Z^2 law found for the Rossi curve at small thicknesses. This is possibly explained by the simultaneous effects of a light quantum and an electron. The spread of showers from air is discussed in this connection. AUTHOR.

***244. Source of Cd Resonance Radiation of High Intensity and Photosensitised Reaction of H_2 and C_2H_4. E. W. R. Steacie and R. Potvin.** *Canad. J. of Research*, 16. *Sect. B. pp.* 337–340, *Oct.*, 1938.—An inexpensive and convenient source of Cd resonance radiation (λ 3261) of high intensity has been developed. This should make possible more extended studies of Cd photosensitised reactions. Some preliminary results on the reaction between H_2 and C_2H_4 are reported. AUTHORS.

See also Abstracts 213, 247, 276.

FLUORESCENCE AND PHOSPHORESCENCE. LUMINESCENCE AND AFTERGLOW.

245. Relation between Fluorescence and Chemical Constitution. G. Brooks. *Comptes Rendus*, 207. *pp.* 726–728, *Oct.* 24, 1938.—The fluorescence of laccol and moreacol obtained from the latex of certain Indo-Chinese trees has been examined, and the results indicate a connection between fluorescence and chemical constitution. In these cases the fluorescence is intimately connected with the presence of a double bond. A. J. M.

246. Bioluminescence. B. Ghosh. *Science and Culture,* 4. *pp.* 215–216, *Oct.,* 1938.—No new results are presented in this paper which confines itself to a description of the phenomena and discusses the photochemical reactions involved. A. H.

***247. Physics of Luminescent Substances in Discharge Lamps. R. Frerichs.** *Naturwiss.* 26. *pp.* 681–687, *Oct.* 21, 1938.—An outline is given of existing knowledge of the physical processes which lead to the emission of light by phosphorescent substances such as are now used in gas discharge lamps. The light emission obtainable with Hg, low and high pressure, and Ne discharge lamps is specially considered. The possibilities of excitation by kathode rays instead of light are examined. W. S. S.

INTERFERENCE, DIFFRACTION AND SCATTERING.

***248. Theory of Gratings. V. S. Ignatovskij.** *Comptes Rendus (Doklady) de l'Acad. des Sciences, U.S.S.R.* 20. 2–3. *pp.* 105–108, 1938. *In German.*—A mathematical treatment of diffraction at a plane grating of infinite extent. C. B. A.

249. Diffraction of Waves by Ribbons and by Slits. P. M. Morse and P. J. Rubenstein. *Phys. Rev.* 54. *pp.* 895–898, *Dec.* 1, 1938.—The exact solution of the diffraction problem in elliptic cylinder coordinates is computed by the use of newly computed tables of Mathieu functions. Curves are given for the distribution-in-angle and total intensity scattered, for the diffraction by a slit or the scattering by a thin ribbon, of waves whose length is the same order of magnitude as the slit or ribbon width. The curves are for different angles of incidence, for different wave-lengths, and for two boundary conditions: zero value and zero normal gradient. AUTHORS.

250. Asymptotic Series for Functions in Diffraction Theory of Light. W. Pauli. *Phys. Rev.* 54. *pp.* 924–931, *Dec.* 1, 1938.—For Sommerfeld's exact solution of the problem of the diffraction of light by a wedge, limited by two perfectly reflecting planes, new asymptotic formulæ are given; these also hold near one of the boundaries between light and shadow, at a distance from the diffracting body which is large compared with the wave-length of light. AUTHOR.

251. Anomalous Propagation of Phase in the Focus. A. Rubinowicz. *Phys. Rev.* 54. *pp.* 931–936, *Dec.* 1, 1938.—The problem of anomalous phase propagation of a spherical wave at the focus has been discussed for the case of a diffracting aperture of arbitrary shape. The solution given by Kirchhoff's integral has been split up into an "incident light wave," which shows the distribution of light to be expected according to geometrical optics and a "diffracted wave," which may be thought of as due to scattering of the incident wave at the diffracting edge. A sudden change of phase by π has been shown to occur already in the incident wave. Thus we may, in this sense, consider this phenomenon as a geometric optical one. The case of a circular diffracting aperture, the focus lying on the normal through its centre which has been treated usually, appears to be not very suitable for an experimental investigation of the discussed phenomenon. It is this particular shape of the diffracting edge, which produces diffraction phenomena of considerable light intensity along the optical axis. These, however, are not because of the existence of a focus, but only because of the particular shape of the diffracting aperture. AUTHOR.

See also Abstract 275.

PHOTOCHEMISTRY (INCLUDING PHOTOGRAPHY).

252. Quantitative Measurement of U.V. Activation of Sterols. Part I. Ergosterol. R. S. Harris, J. W. M. Bunker and L. M. Mosher. *Am. Chem. Soc., J.* 60. *pp.* 2579–2580, *Nov.*, 1938.—The photochemical activation of ergosterol in ether by monochromatic u.v. light of 2537, 2652, 2804, 2967 or 3025 Å, is substantially uniform per quantum of energy applied. AUTHORS.

253. Calculation of Bond Strengths from Photochemical Evidence. M. Burton. *J. Chem. Phys.* 6. *pp.* 818–823, *Dec.*, 1938.—When predissociation manifests itself in polyatomic molecules by a sudden broadening of the rotation lines of a discrete absorption spectrum, a close correspondence is to be expected between the beginning of the predissociation region and the strength of the bond involved. This principle is used to calculate the bond strengths of C–C in ethane, acetaldehyde, acetone and free acetyl (values: 72·1, 93·1, 96·5 and −19·4 kg.cal., respectively) and of C–H in methane, acetaldehyde, formaldehyde and free formyl (values: 94·8, 114·7, 103·3, and 0·1 kg.cal., respectively), where the bond strength is defined in reference to the state of the molecule at 0° K. Assuming the validity of the method, the bond strength values given are shown to be accurate within 1·0 kg.cal. The limitations of the method as well as some implications of the results are indicated. AUTHOR.

254. Migration and Photochemical Action of Excitation Energy in Crystals. J. Franck and E. Teller. *J. Chem. Phys.* 6. *pp.* 861–872, *Dec.*, 1938.—A crystal which has absorbed a light quantum can be treated either as an assembly of molecules or else as a giant molecule. If the exchange of excitation energy between crystal cells is slow as compared to the periods of vibration, the first description is preferable; if it is fast, the second picture is better. Both cases are discussed in connection with the following question: To what extent can excitation energy absorbed by an arbitrary cell of the crystal be used photochemically at a specific point which may be far removed from the absorbing cell? The results are applied to the behaviour of polymerised pseudoisocyanines, to the hypothetical photosynthetic unit and to the theory of sensitised photographic plates. AUTHORS.

255. Relations Between Sensitometric and Size-Frequency Characteristics of Emulsions. L. Silberstein and A. P. H. Trivelli. *Kodak Research Lab., Comm. No.* 679. *J.O.S.A.* 28. *pp.* 441–459, *Nov.*, 1938.—Theoretically examines the numerical relations existing between the sensitometric and the grain-size characteristics of emulsions, considering general formulæ, exponential size-frequency distribution, normal size-frequency distribution, double and multiple quantum hits (dealing with normal size-frequency and exponential size-frequency distribution), and, finally, general relations for any size-frequency distribution. R. C. F.

256. Action of AgBr in AgI Emulsions. A. P. H. Trivelli and W. F. Smith. *Phot. J.* 78. *pp.* 644–645, *Nov.*, 1938.—The effect of adding AgI to AgBr emulsions is to reduce the grain size with consequent increases in H and D speeds, the increase being explained by the strain which AgI in small quantities produces in the crystal structure of AgBr. It is expected that AgBr in small quantities will produce strains in the AgI crystal structure, thereby giving rise to higher speed emulsions than can be obtained with AgI alone. This is borne out by results obtained when emulsions with different AgBr contents are compared. R. C. F.

257. Spontaneous Alteration of Latent Image. F. Urbach and A. Wolinski. *Akad. Wiss. Wien, Ber.* 147. 2*a*. 1–2. *pp*. 29–36, 1938.—From an examination of the stability of the latent image in relation to the destruction by red light it is shown that the formation of the developable impression on the photographic plate does not cease with the completion of the illumination period, but the stabilising of the photochemical reaction products continues slowly for some time afterwards. The strong obliterating action brought about by illuminating, with red light, the latent image during its formation, is due to the low stability of the recently formed image. A considerable reduction in the obliterating action is obtained by allowing a long time to elapse between the image production and the after-illumination with red light. Actually, the spontaneous stabilising of the latent image is not complete even after a time interval of 20 hr. R. C. F.

258. Humidity Effect upon Photographic Latent-Image Formation. G. Z. Dimitroff. *Harvard Coll. Obs., Circ. No.* 430. [14 *pp*.], 1938.—Examines the effects of humidity at given temperatures from results obtained at high and low humidities on a large number of plates of different emulsions. It is found that the background density in many cases increases with decreases in humidity, and in some cases the graininess of the emulsion is improved when the plates are treated with dry air. The effect of humidity on the contrast depends on the emulsion, and for different spectral regions is affected differently with increases in humidity. Change in sensitivity is found to depend on the type of emulsion, the time of treatment, the percentage change in humidity, the atmospheric temperature, and the intensity of the incident beam and its spectral composition. Finally, the effects of humidity should be controllable, as they are predictable when conditions of humidity and temperature are known. R. C. F.

259. Theory of Schwarzschild Effect. Part I. A. Narath. *Zeits. f. wiss. Phot.* 37. *pp*. 162–192, *July–Aug*., 1938.—Critically examines previously published work in an endeavour satisfactorily to explain the Schwarzschild effect, dealing with the representation of the It law, and the dependence of the effect on the different parameters—type of emulsion, wave-length, and temperature. The Schwarzschild exponent p, which is defined for only a single blackening value, cannot be expressed as a function of the gamma value, for with equal gamma values, the p values are found to be different in some cases. The dependence of the effect on the emulsion is illustrated by the fact that with low-sensitivity emulsions the deviations are generally larger than with high-sensitivity emulsions. R. C. F.

260. Solarisation and the Capri-Blue Effect. Lüppo-Cramer. *Phot. Indust.* 36. *pp*. 1227–1228, *Nov*. 9, 1938.—Deals briefly with results which show the sensitisation of solarised emulsions produced by Capri-blue dye solution. It is also shown that this sensitisation of solarised AgBr emulsions by dyes is a general effect brought about by desensitising, as well as sensitising, dyes. R. C. F.

261. Failure of Reciprocity Law at Low Intensity. J. H. Webb and C. H. Evans. *Kodak Research Lab., Comm. No.* 687. *J.O.S.A.* 28. *pp.* 431–436, *Nov.*, 1938.—A study of the failure of the reciprocity law at low intensity in photographic exposure was carried out by means of a series of equal energy exposures made partly with high intensity and partly with low intensity illumination. The high and low intensity parts were given in different time order. The results indicate that the failure of the reciprocity law at low intensity is because of a regression of the latent image speck in its initial stages of formation, while it is still small. If the speck is built up to a stable size by a primary high intensity exposure, then subsequent exposure at low intensity can continue to build up the speck as efficiently as exposure at high intensity. The results show that there can exist a latent image speck, which is stable, but which is not yet developable. [See Abstract 3688 (1938).] AUTHORS.

262. Theory of Three-Colour Reproduction. D. L. MacAdam. *Kodak Research Lab., Comm. No.* 680. *J.O.S.A.* 28. *pp.* 399–418, *Nov.*, 1938.—The colorimetric and photographic principles of additive colour reproduction are reviewed. The significance of the concept of photographic spectral sensitivity is examined, and the desirability of emulsions having contrast independent of wave-length is emphasised. Although the desirability of partially negative spectral sensitivities, such as described by Hardy and Wurzburg, is acknowledged, the photographic methods proposed by those authors for the realisation of such sensitivities are shown to be rendered useless by fundamental difficulties. Two masking methods are described, one of which utilises unusual types of emulsions to realise completely the desired partially negative spectral sensitivities, and the other of which utilises conventional materials and techniques to realise a close approximation to the desired sensitivities. The errors of additive colour reproductions resulting from several different compromises in which negative portions of the spectral sensitivity curves are ignored or avoided are computed and compared. The simple omission of all sensitivity in the wave-length regions where the theory calls for negative sensitivity, utilising only the positive portions of the theoretical spectral sensitivity curve, results in the smallest errors. Finally, the effect of increase of contrast is examined, with the conclusion that purity can be increased, compensating for the loss of purity resulting from the failure to realise partially negative spectral sensitivities, but that considerable errors in dominant wave-length as well as in brightness result from the excessive contrasts. [See following Abstract.] AUTHOR.

263. Subtractive Colour Mixture and Colour Reproduction. D. L. MacAdam. *J.O.S.A.* 28. *pp.* 466–480, *Dec.*, 1938.—The colours of mixtures of certain sets of dyes can be predicted to a close approximation through the use of a simple rule. The analytical form of this rule is sufficiently simple to permit its incorporation into the theory of colour reproduction. This inclusion of the phenomena of subtractive mixture to the theory leads directly to the conclusion that masking is an essential step in any realisable subtractive process of correct colour reproduction. Formulæ for the calculation of the gradients of the masks are given in terms of the parameters of the rule for the prediction of the colours of mixtures of the dyes to be used in printing the subtractive reproduction. Formulæ are also given for the calculation of the gradients of masks to be used for the simultaneous introduction of partially negative spectral sensitivities. An application of these formulæ to the Eastman wash-off relief process shows that the negative portions of the theoretically desirable spectral sensitivities are negligible, and that each separation negative need be printed in register with only one mask. [See preceding Abstract.] AUTHOR.

264. Theory of Subtractive Colour Photography. Part I. Conditions for Perfect Colour Rendering. J. A. C. Yule. *Kodak Research Lab., Comm. No.* 684. *J.O.S.A.* 28. *pp.* 419–430, *Nov.*, 1938.—The conditions necessary for obtaining perfect colour reproduction in a subtractive process in which imperfect dyes or pigments are used are described. It is concluded that the masking method, or some mathematically equivalent process, must be used, and that not even this will give perfect reproduction unless many special requirements are fulfilled. These involve the absorption curves of the dyes, the shape as well as the contrast of the characteristic curves of all materials used, the effective spectral sensitivities of the emulsion-filter combinations, and, of course, the colour balance of the final reproduction. It is theoretically possible to obtain a perfect reproduction by purely photographic means, and probably quite practicable to obtain a close approximation to perfection in many cases experimentally. In a second paper a method of deciding on the most favourable conditions for use in practice will be described. [See following Abstract.] AUTHOR.

265. Theory of Subtractive Colour Photography. Part II. Prediction of Errors in Colour Rendering Under Given Conditions. J. A. C. Yule. *J.O.S.A.* 28. *pp.* 481–492, *Dec.*, 1938.—By the use of a special form of colour chart, the errors in colour rendering resulting from any given combination of dyes and filters can be predicted. The effect of any combination of masks can also be calculated. A method of improving the results by means of partial exposures through two colour filters in making the colour separation negatives is described. A method of determining the errors due to the fact that spectral sensitivities fail to correspond to the colour mixture curves for the human eye is described. [See preceding Abstract.] AUTHOR.

***266. Magazine Plate Camera for Photography in Vacuum. K. E. Fitzsimmons.** *J.O.S.A.* 28. *pp.* 437–439, *Nov.*, 1938.—A magazine plate camera which provides for 8 to 16 separate exposures on 3¼″ × 4″ plates without disturbing the vacuum has been built for use with a high magnification electron microscope. Visual focusing of the image formed by the electron beam on a fluorescent screen is possible before each exposure. The camera is compact and the mechanical operation is smooth and positive. It is presumably generally adapted to photography in vacuum apparatus. AUTHOR.

***267. Densitometry of X-Ray Films and its Standardisation. J. E. de Graaf.** *Zeits. f. wiss. Phot.* 37. *pp.* 147–159, *July-Aug.*, 1938.—In order to assist in understanding the large differences obtained when the same densitometric strips are measured with different densitometers, the influence of the incident angle of the light on the film, of the light scattering by the film, of the aperture of the receiver, and of the angular spread of the pencil of rays was examined. From this examination conclusions are drawn regarding the construction of a densitometer, and the visual examination of the film. R. C. F.

***268. Photoelectric Densitometer. J. E. Morgan and R. J. Reeves.** *Am. J. of Roentgenology and Radium Therapy*, 40. *pp.* 610–615, *Oct.*, 1938.—Recently electro-optical methods have been applied for the accurate determination of X-ray film density. Many such densitometers have been designed which are discussed in respect to accuracy, constancy of readings, flexibility, speed of manipulation, simplicity, low cost and easy maintenance. Of all types investigated there is a source of illumination which is transmitted *via* the film and the emerging light is converted to electrical energy with a means of measuring this resulting energy. Suitable balanced circuits for this purpose are described, with an improved apparatus which is shown schematically and in photograph, the instrument having been applied with satisfactory results in practice. B. J. L.

***269. Standardisation of Photographic Densitometry. C. Tuttle and A. M. Koerner.** *Phot. J.* 78. *pp.* 739–742, *Dec.*, 1938.—It is desirable that all laboratories dealing with photographic problems shall be in agreement upon the significance of the term " density " and that the means for numerical determination of this value shall be specifiable. In different optical systems, the apparent " light stopping power " of a given photographic image specimen will vary because of the manner in which that sample reflects, scatters, and absorbs light. Since the numerical value obtained depends upon the characteristics of the optical system used in the densitometer, it becomes necessary to specify the optical system to be used as a reference standard. Because it may be definitely specified, the integrating sphere is suggested as the light collector for this standard optical system. Precautions which must be followed in the use of the sphere for this purpose are enumerated. It is shown that once some standard optical system is adopted, several other types of optical systems may be employed in practical instruments if the calibration of these instruments is made under actual working conditions with photographic images previously measured in the system adopted as standard. The paper concludes with a discussion of the inter-relationships of $\log._{10}$ apparent opacity as determined in several optical systems commonly used in densitometry. AUTHORS.

270. Absorption Spectrum of Developed Photographic Image. C. Jausseran. *Comptes Rendus*, 207. *pp.* 783–786, *Nov.* 2, 1938.—The following results were obtained :—(*i*) All the plates examined exhibit the transparency band of Ag ; (*ii*) for normal exposures, the relative importance of this band, for similar densities, depends on factors such as the nature of the emulsion, time of exposure, method and time of developing, but only the last of these is of great importance ; (*iii*) the absorption curve of a solarised image developed normally is similar to that of a very underdeveloped normal image. C. B. A.

271. Microscopy of Photographic Papers. K. Kieser. *Phot. Indust.* 36. *pp.* 1253–1256, *Nov.* 16, 1938.—Briefly examines methods used in the preparation and microscopic examination of photographic papers, and shows that the production of cross-sections of photographic papers requires only the use of comparatively simple methods. R. C. F.

See also Abstracts 211, 244, 362, 433 and
159B. Photographic Illumination. T. T. Baker.

PHOTOMETRY.

***272. Visual Telephotometry. L. J. Collier.** *Illum. Eng. Soc.* (*London*), *Trans.* 3. *pp.* 141–152 ; *Disc.*, 152–154, *Oct.*, 1938.—Telephotometers, used for measuring the candle-power of intense light sources situated at great distances from the observer, are of three kinds, *viz.*, (*a*) those in which the distant (point) source is compared with a local point source of variable intensity, (*b*) those in which the brightness of a very large diffusing surface at the distant point is compared with that of a local diffusing surface of variable brightness and (*c*) those in which an image of the distant point source is formed at the observer's eye by means of a lens system, so that the lens appears as a uniformly bright area which can be compared with a local area of variable brightness. Instruments of all three kinds are described in detail and a critical account of their performance is given, with particular reference to the measurement of atmospheric transmission over long ranges. In the *Discussion*, **J. M. Waldram** described an instrument for measuring atmospheric transmission over short ranges. J. W. T. W.

*273. **Rapid Microphotometry. G. O. Langstroth and D. R. McRae.** *J.O.S.A.* 28. *p.* 440, *Nov.*, 1938.—Describes a form of photoelectric microphotometer in which the known densities of the calibration marks are registered graphically. A smooth curve is then drawn on the graph and the deflection corresponding to any unknown density gives, by means of this graph the correct value of the density. The precision is stated to be equal to that obtained by the ordinary method of using a direct-reading microphotometer, while the speed of working is much higher. J. W. T. W.

*274. **New Sensitive Light-Counter. R. Tzschaschel.** *Zeits. f. Physik*, 111. 3–4. *pp.* 215–231, 1938.—A description is given of a light-counter which has the characteristic of registering each liberated photoelectron. For this purpose the primary electrons are driven into a homogeneous field and reduplicated by ionisation through collision. The electrons of the hereby arising electron showers pass partially through a net in the counting region of a point counter and bring this into action. The counting characteristics of this apparatus are connected with the darkness effect. Capacity for liberation and characteristic excitation are investigated and discussed. The relative yield, *i.e.*, the ratio of the counted impulses to the primarily produced electrons, is a function of the field strength. Then there arises a saturating value of 0·25, *i.e.*, each fourth photoelectron is counted. J. J. S.

275. Astigmatism of Concave Grating as a Means of Calibrating Photographic Plates in Intensity Measurements. M. I. Bresch. *J.O.S.A.* 28. *pp.* 493–499, *Dec.*, 1938.—The intensity of the astigmatic spectral image formed by a concave grating is a maximum at the centre and drops off to zero at the ends of the line. Inasmuch as the intensity distribution can be known from the value of the astigmatism factor, G. H. Dieke has suggested using such an image as a means for calibrating a photographic plate in intensity measurements [see Abstract 4055 (1933)]. It has been the purpose of this investigation to develop the method in detail, to apply it to the calculation of relative intensities, and to compare the results with those obtained from one or another of the standard methods now in use. Under proper conditions the astigmatism method has the great advantage of simplicity, and it was found to yield results which compare favourably with those obtained by other means. AUTHOR.

*276. **Light-Technics. Part II. H. Ewest, M. Reger and R. Rompe.** *Die Physik*, 6. 4. *pp.* 181–192, 1938.—In continuation of the work of a previous paper [see Abstract 3687 (1934)], a brief synopsis is given of a wide selection of papers bearing on light technology under the headings; physiological optics, photometry, physics and technology of light sources, illumination research. About 200 references are given. W. S. S.

POLARISATION.

277. Degree of Depolarisation of Light Scattered by Molecules in Liquids and the Kerr Constant. H. A. Stuart and W. Buchheim. *Zeits. f. Physik*, 111. 1–2. *pp.* 36–45, 1938.—The degree of depolarisation of molecules by scattered light, and the Kerr constant, determined for 19 liquids, are not related accurately according to the equation deduced from the fluctuation theory. Possible explanations of the observed discrepancies are discussed. W. R. A.

278. Scattered Light from Polaroid Plates. H. W. Farwell. *J.O.S.A.* 28. *pp.* 460–461, *Nov.*, 1938.—Examination of the light scattered by a Polaroid plate shows it to be strongly polarised in the same direction as the transmitted light. The phenomenon appears to be due to diffraction and is governed by the orientation of the plate. The order of magnitude of the scattered light intensity is (at its maximum) about one sixteen-thousandth of the transmitted beam, and about one third of this as a minimum. A. H.

279. Rotatory Power of Citrulline. R. Duschinsky. *Comptes Rendus*, 207. *pp.* 735–737, *Oct.* 24, 1938.—Naturally-occurring citrulline is shown for the first time to be optically active. It is dextro-rotatory, the rotatory power depending on the pH of the solution. A synthesis, yielding a product which is equally dextro-rotatory, is described. **Erratum,** *ibid. p.* 1135, *Dec.* 5, 1938. C. B. A.

280. Optical Activity of Secondary Butyl Alcohol. E. Gorin, J. Walter and H. Eyring. *J. Chem. Phys.* 6. *pp.* 824–832, *Dec.*, 1938.—A calculation of the optical activity of secondary butyl alcohol is presented based upon a one-electron model. The chromophoric electron is considered to be one of the non-bonding electrons on the O atom. This electron is considered to be moving in a field of the other nuclei and electrons considered as charge distributions. The fields of the other electrons are obtained from the Slater type eigenfunctions for the various atoms. This amounts to a rough solution of the Hartree approximation for the chromophoric electron. The results obtained are somewhat larger or somewhat smaller than the experimental value depending on the exact orientation of the groups in their rotation about single bonds. The assignment of an absolute configuration in these calculations follows, provided the exact orientation of the rotating groups is known. The orientations which the authors consider most likely lead to an assignment of the absolute configuration in agreement with that of Kuhn [see Abstract 2877 (1938)]. AUTHORS.

See also Abstracts 49, 56, 302.

REFLECTION, REFRACTION AND DISPERSION.

281. Optical Silvering on Glass. B. Dasannacharya and A. C. Seth. *Phil. Mag.* 26. *pp.* 953–970, *Dec.*, 1938.—The Brashear chemical method of silvering described in 1883, which is essentially the older Martin process (1863) is used to study the optimum conditions of silvering, the influence of cleaning the surface to be silvered, and the effect of temperature. Rubbing with soap and water, then dipping for a few minutes in water followed by washing with tap water then with distilled water is an adequate cleaning process. Excess of $AgNO_3$ present in the ammoniacal $AgNO_3$ and KOH solution prior to mixing with the reducing solution leads to the development of spots in the mirror; excess of NH_3 reduces the rate of deposition of Ag but yields uniform deposits. Irrespective of the concentration of the $AgNO_3$ solution, the optimum condition of silvering is obtained when the glass surface silvered is, on the average, 525 cm.^{2} per gm. of $AgNO_3$. The best temperature for deposition is about 20° C.; very good mirrors were obtained at 27° C. The amount of Ag deposited in a given time at 10° C. and 27° C. is about half that deposited in the same time at 21° C.; at 35° C. it is about 1/4 of that at 21° C.; at 0° C. deposition is very slow. J. S. G. T.

282. Reflection and Transmission in Thin Metal Films. K. Koller. *Zeits. f. Physik*, 110. 11–12. *pp.* 661–675, 1938.—The reflecting and transmitting powers of various thin metal films supported on transparent substrates are computed and certain special cases are discussed. A new formula is suggested which, it is claimed, is free from many of the limitations of the earlier one due to Goldschmidt. A. G. Q.

283. Transformation of Seidel Partial Coefficients and its Application. S. Maruyama. *Phys. Math. Soc. Japan, Proc.* 20. *pp.* 861–864, *Oct.*, 1938. *In English.*—The paper deals with: (1) Seidel partial coefficients for the image defects; (2) Transformation of the partial coefficients; (3) Combination of two systems. In optical design, use is often made of a method of computation of a ray from left to right and *vice-versa*, with subsequent combination for making two image points coincident, and the present section indicates how to deal with equations involving Seidel sums; (4) A theorem about a symmetrical system. Here one optical system is combined with another where constants (*i.e.*, the radii, thicknesses, intercepts, etc.) are *m* times the corresponding quantities of the former, the latter system being placed in the reverse sense next to the former. H. H. Ho.

***284. Application of Schmidt Principle to Microscopy. E. H. Linfoot.** *Journ. Sci. Instruments*, 15. *pp.* 405–406, *Dec.*, 1938.—A description is given of the methods by which figured Schmidt plates, of glass and quartz respectively, were constructed for use in microscopes operating on the Schmidt principle. The first microscope, of numerical aperture 0·41, is for visual use; the second, of numerical aperture 0·54, is suitable both for visual and for u.v. microscopy. AUTHOR.

See also Abstracts 14, 56, 284, 303.

SPECTROSCOPY.

***285. Spectrographic Analysis of Metals by Condensed Spark and Interrupted Arc. A. Beerwald and W. Seith.** *Zeits. f. Elektrochem.* 44. *pp.* 814–823, *Nov.*, 1938.—The spectrographic effects of sparking metallic electrodes and the accompanying phenomena are discussed. In the case of spark discharge between electrodes of hydronalium, two phenomena were observed: (1) The unequal removal of the material from the surface of the electrodes; (2) The change with time of the distribution of concentration, and the consequent change in emission intensity. The interrupted arc of Pfeilsticker was tested for use in spectrographic analysis of metals. Its applicability was demonstrated for the estimation of Si in Al, Mg in Al, Be in Cu, and Al in Mg. A special "screw electrode" was designed, by means of which it was possible to cause the spark discharge to take place over the greatest possible surface of the metal during the exposure of the photographic plate. F. J. B.

286. Absorption Spectrum of Thorium. T. L. de Bruin and J. N. Lier. *K. Akad. Amsterdam, Proc.* 41. 9. *pp.* 956–964, 1938.—The absorption spectrum of Th is studied by means of the under-water spark and exploding wire methods. With the first method emission lines due to Th III are obtained whilst, depending on the conditions, emission or absorption lines of Th II are observed. With the second method no Th III lines appear, all the lines being attributable to Th I or II. All the absorption lines observed are tabulated, the region covered being from λ 5050 to λ 2190. A. H.

287. Origin of Colour of Paramagnetic Ions in Solution. D. M. Bose and P. C. Mukherji. *Phil. Mag.* 26. *pp.* 757–776, *Nov.,* 1938. *Supplement.*—The paper contains the available data on the absorption spectra of solutions containing paramagnetic ions, excluding those due to the rare-earth ions. An empirical formula is put forward to account for the number and frequency of the principal absorption bands, without considering the subdivision and finer structure of the bands. The assumptions on which the formula is based are set forth. G. E. A.

288. Deep Terms in Co VI and Ni VII. L. W. Phillips and P. G. Kruger. *Phys. Rev.* 54. *pp.* 839–841, *Nov.,* 1938.—About 90 lines in the Ni VII spectrum have been identified as radiations connecting terms from the $d^3 4p$ configuration with those arising from the d^4 ground state configuration. The lines and 44 of the deep terms are listed. The corresponding terms in Co VI agree with Bowen's recently published analysis. Some alternative classifications are listed. F. S.

289. Spectral Series of HeI. W. v. Meyeren. *Zeits. f. Physik,* 111. 1–2. *pp.* 46–54, 1938.—The spectrum produced by the excitation of He by rapid electrons (1800 eV) at $1 \cdot 5 \times 10^{-4}$ torr. pressure has been examined, and the intensity of ten lines lying in the visible region has been determined by photographic-photometric methods. Within the individual series remarkable deviation from the normal intensity was observed, the intensity increasing with successive members of the series. In the subsidiary series $2^1P - n^1D$ seven new members have been found. W. R. A.

290. Quantum-Mechanical Calculation of the Effect of Pressure on Spectral Lines. Part I. C. Reinsberg. *Zeits. f. Physik,* 111. 1.–2 *pp.* 95–108, 1938.—The general theory of broadening and displacement of spectral lines by pressure is developed on a quantum-mechanical basis. The Lorenz theory of collision damping and Margenau's statistical theory are derived, and the former is extended so as to explain line displacements. The optical effective cross-sectional areas can be calculated on this theory without serious assumptions. C. B. A.

291. Resonance Broadening of Spectral Lines. W. V. Houston. *Phys. Rev.* 54. *pp.* 884–888, *Dec.* 1, 1938.—A general treatment of the collision of an excited atom with an unexcited one shows that the three principal methods of calculating collision broadening are all justified as approximations to the complete treatment. When the fine structure of the lines is taken into account it follows that all members of a Russell-Saunders multiplet are broadened to the same extent. The calculated broadening turns out to be $\Delta\nu = (\frac{3}{2})^{\frac{1}{2}} \mathrm{NS}(\mathrm{J}, \mathrm{J}')/h(2\mathrm{J} + 1)(2\mathrm{J}' + 1)$, which is less by a factor of five than that observed in the work of Hughes and Lloyd [see Abstract 692 (1938)]. AUTHOR.

292. Magnetic Moments of Heavy Nuclei. T. Neugebauer. *Zeits. f. Physik,* 111. 1–2. *pp.* 125–132, 1938.—It is shown that the empirical rules for calculating the magnetic moments of nuclei containing an odd proton which have been given by Schmidt and Schüler [see Abstracts

4051 and 4974 (1937)] can be deduced quite naturally, and without introduction of arbitrary hypotheses, by taking into account the h.f. paramagnetic susceptibility of the nuclear core; this susceptibility is of a significant order of magnitude in the nucleus although quite insignificant in the electron shells of molecules. A similar deduction can be made by considering the diamagnetic susceptibility and making use of a hypothesis due to Wick concerning proton disintegration. The calculations are independent of the laws of force within the nucleus. J. E. K.

293. Effect of Radiation Damping and Doppler Broadening on the Atomic Absorption Coefficient. D. G. Kendall. *Zeits. f. Astrophysik*, 16. 5. *pp.* 308–317, 1938. *In English.*—Voigt's integral for the atomic absorption coefficient, allowing for radiation damping and Doppler effect, is discussed as a function of a frequency variable, x, and a parameter, α. It is evaluated in terms of error functions of a complex-variable, and expanded as an infinite series which converges rapidly for small α. This result is compared with the usual approximation, and it is shown that observable deviations will occur when α is larger than $0\cdot1$.

294. Transitions Between Levels Spaced Almost Continuously. A. Landé. *Phys. Rev.* 54. *pp.* 940–944, *Dec.* 1, 1938.—The transition probabilities between closely spaced energy levels, when calculated according to the usual perturbation methods, lead to apparent infinities if the perturbation is finite. A more appropriate method of approximation which disposes of the infinities is worked out. The resulting finite transition probabilities are identical with the finite parts of the usual expressions in first and second order, but additional finite terms appear in orders higher than the second. AUTHOR.

295. Infra-Red Absorption Spectra of Silicates. F. Matossi and O. Bronder. *Zeits. f. Physik*, 111. 1–2. *pp.* 1–17, 1938.—The infra-red absorption spectra from 1–$8\cdot5\mu$ (and for some to 15μ) of seven silicates and one glass have been investigated. The spectra are explained on the basis of the combination frequencies. Available reflection measurements and Raman data are discussed. The previous evidence for the existence of an inactive frequency of pulsation at 800 cm^{-1}. is supported. The influence of the water content on the spectrum has also been considered. W. R. A.

296. Infra-Red Absorption Spectra of Sugars and Furans. L. H. Rogers and D. Williams. *Am. Chem. Soc., J.* 60. *pp.* 2619–2621, *Nov.*, 1938.—The infra-red absorption spectra for four furan derivatives, four pentoses and four hexoses between 2 and 12 μ have been mapped and the results compared with Raman and infra-red data from other sources. Several bands were common to all the furans. Data on sugar solutions are in fair agreement with earlier results obtained in studies of melted compounds. No pronounced differences occurred between the spectra of any of the sugars studied. AUTHORS.

297. Infra-Red Absorption of Carboxylic Acids in Solution. Part I. Qualitative Features. Part II. Intensities. M. M. Davies and G. B. B. M. Sutherland. *J. Chem. Phys.* 6. *pp.* 755–770, *Dec.*, 1938.—In Part I the absorption spectra of solutions of acetic, benzoic and trichloracetic acids in CCl_4 have been studied at various concentrations and temperatures in the neighbourhood of 3μ, 6μ and 7μ. At each of these regions is a double band, one component of which is due to the monomeric, the other to the dimeric form of the molecule. The relatively small shift in each case indicates that the molecule is not radically altered on association. The absorptions in the three regions studied were due respectively to the O–H, the C = O and the C–O bonds of the COOH group. It has been possible to make a first estimate of these bond distances in the monomer and dimer, as follows (in A units) :

	O — H	C = O	C — O
Monomer	$0 \cdot 9_{81}$	$1 \cdot 1_{95}$	$1 \cdot 2_{98}$
Dimer	$1 \cdot 0_{4}$	$1 \cdot 2_{11}$	$1 \cdot 2_{85}$

The values for the C = O and C — O distances are in satisfactory agreement with those deduced by X-ray methods for oxalic acid but not with those obtained by electron diffraction for formic acid. The general appearance and the temperature variation of the O — H "association" band in these acids appears to be very similar to that of the corresponding band in the alcohols. This is evidence in favour of Badger's explanation of the width of such bands rather than Errera's. In Part II the integral absorption of the monomeric OH band has been measured for solutions of acetic, benzoic and lauric acids in CCl_4 at various concentrations and temperatures. At any given temperature the results indicate that the integrated intensity is roughly proportional to the amount of the monomer present, assuming that there is a monomer $\rightleftharpoons$ dimer equilibrium. The temperature variation of the integrated absorption gave values for the heat of association varying from 600 to 10,000 cal./mol. which is considerably below the accepted value of 15,000 cal./mol. This difference is attributed to the variation in the absorption coefficient with temperature. Equally anomalous results were obtained from measurements on the intensity of the monomeric C = O band. The variation of the absorption coefficient with concentration and with temperature was checked independently on solutions of cetyl alcohol in CCl_4. AUTHORS.

298. Infra-Red Study of ω-Hydroxyundecanoic Acid in CCl_4. M. M. Davies. *J. Chem. Phys.* 6. *pp.* 770–774, *Dec.*, 1938.—An infra-red examination of a long chain ω-hydroxycarboxylic acid has provided evidence as to the inter- and intramolecular association of such molecules in solution. In particular, it is believed that the occurrence of a cyclic form of the monomeric molecules in solution has been proved. AUTHOR.

299. Infra-Red Bands of Methylamine and Free Rotation. H. W. Thompson and H. A. Skinner. *J. Chem. Phys.* 6. *pp.* 775–778, *Dec.*, 1938.—Two bands in the absorption spectrum of CH_3NH_2 have been measured in the photographic infra-red. One of the bands shows rotational structure. The bands have been interpreted as involving excitation of the frequencies $3\nu_{NH}$ and $(3\nu_{CH} + \nu_{CN})$. The rotational structure of the latter band suggests that it is a perpendicular-type band, and the precise spacing of the Q branches suggests that the molecule behaves approximately like a grid symmetric top. The inference of hindered internal rotation is in agreement with other independent data. AUTHORS.

300. Term Scheme of Sulphur Bands. E. Olsson. *Arkiv f. Mat. Astron. och Fysik, Stockholm*, 26*B*. 9. [4 *pp.*], 1938. *In German.*—The published values have been analysed and a term scheme is listed including the A-bands and the "weak systems" of Curtis and Tolansky. F. S.

301. Band Spectrum of Se. E. Olsson. *Arkiv f. Mat. Astron. och Fysik, Stockholm*, 26*B*. 10. [5 *pp.*], 1938. *In German.*—All the bands of Se_2 which have been investigated show a shift of about 20 cm^{-1}. from the undisturbed position, while no disturbance of rotation has been found.

Certain of the bands are re-examined in an effort to explain this contradiction. F. S.

***302. Spectrochemical Study of Microscopic Crystals. Part I. Application of Microscopes in Spectrography. R. Tsuchida and M. Kobayashi.** *Chem. Soc. Japan, Bull.* 13. *pp.* 619–623, *Oct.*, 1938. *In English.*—A new method of measuring absorption spectra of microscopic crystals has been introduced. Application of a polarising microscope renders it possible to measure pleochroism of microcrystalline substances. An example is shown of cis-dichloro-tetrammine-cobaltic chloride. AUTHORS.

303. U.V. Reflection Spectra of Mo Compounds. Z. Soubarew-Chatelain. *Comptes Rendus,* 207. *pp.* 580–582, *Oct.* 3, 1938.—The u.v. absorption spectra of several solid molybdates have been examined. The systems MoO_3-Li_2O, MoO_3-Na_2O and MoO_3-K_2O indicate the formation of normal molybdates of the type X_2MoO_4, and dimolybdates of the type $X_2Mo_2O_7$. Compounds richer in MoO_3 are shown to be only mixtures of MoO_3 and of dimolybdate, confirming the work of other authors. The normal molybdates, with u.v. non-absorbent kations, show a continuous band characteristic of the MoO_4'' group, with the longer wave-length limit at 2800 Å. U.v. absorbent kations displace this limit towards longer wave-lengths. With kations of the first type, dimolybdates give a limit of 3600 Å approx. The white acid $MoO_3 \cdot H_2O$ gives, not the spectrum of the MoO_4'' radical, but that of Mo_2O_7''. Hence this acid is actually $H_2Mo_2O_7 \cdot H_2O$. Results obtained from the study of the hypsochrome effect of water on $MoO_3 \cdot H_2O$ confirm the results of Billy and Berton [see Abstract 3718 (1938)]. W. R. A.

304. Absorption Spectra in the Near Infra-Red (6000–10000 Å) of Ammonium Salts. P. Barchewitz and G. Costeanu. *Comptes Rendus,* 207. *pp.* 722–724, *Oct.* 24, 1938.—Aqueous solutions of five ammonium salts at various concentrations give three bands at approximately 7530, 8480 and 8160 cm^{-1}. in the near infra-red, of which the latter only is due to the $NH_4^{\cdot}$ ion; it is of relatively weak intensity even at high concentrations of salt, and its exact position depends on the nature of the anion. The intense band 8480 cm^{-1}. is due to H_2O. In the spectrum of NH_4NO_3 in liquid NH_3, the bands of NH_3 obscure that of the $NH_4^{\cdot}$ ion. In liquid SO_2 solution, NH_4CNS gives only one band at 8135 cm^{-1}. This spectrum is similar to that obtained with fused NH_4NO_3 and NH_4CNS in which single bands are observed at 8180 and 8250 cm^{-1}. respectively. W. R. A.

305. Structure and Absorption Spectra of Benzoyl-Benzoic Acid and its Derivatives. Che-Kin Lin. *Comptes Rendus,* 207. *pp.* 733–735, *Oct.* 24, 1938.—U.v. absorption spectra are recorded for benzoyl-benzoic acid and a number of esters and salts. They indicate a ketonic structure for the acid. C. B. A.

306. Near Infra-Red Spectra of Protein. J. W. Ellis and J. Bath. *J. Chem. Phys.* 6. *pp.* 723–729, *Nov.*, 1938.—Near infra-red absorption spectra of protein molecules in oven-dried gelatin and of gelatin saturated with H_2O and D_2O vapour respectively are compared. It is found that certain absorption bands are greatly diminished in intensity by the addition of H_2O molecules and still more diminished by addition of D_2O molecules. Other bands do not change in intensity but some shift their positions in the spectrum. The significance of these changes in terms of the molecular structures are discussed at length. A. H.

307. Spectrophotometric Study of Neutralisation Indicators. W. B. Fortune with M. G. Mellon. *Am. Chem. Soc., J.* 60. *pp.* 2607–2610, *Nov.*, 1938.—A spectrophotometric study has been made covering the transformation range of various simple, modified and mixed neutralisation indicators. The spectral transmittency curves show the characteristics of the absorption bands in the visual region at different pH values. Colorimetric specifications are included for selected curves for several indicators. AUTHORS.

308. U.V. Absorption Bands Ascribed to HNO_2. D. M. Newitt and L. E. Outridge. *J. Chem. Phys.* 6. *pp.* 752–754, *Dec.*, 1938.—Attention is drawn to the similarity of a series of absorption bands obtained by Melvin and Wulf [see Abstract 226 (1936)] as the results of experiments at normal temperatures with a $NO - NO_2 - H_2O$ medium and by Bone and Newitt [see Abstract 2785 (1927)] from the explosion of a $CO - H_2O -$ NO medium at high pressures. The formation of these bands in explosion experiments at atmospheric pressure and in static flames is described and evidence is brought forward which suggests that they may be due to the enhancement of certain bands of the normal NO_2 absorption spectrum. AUTHORS.

309. Kinetics of OH Radicals Determined by Their Absorption Spectrum. Part IV. Pressure Broadening and the Line Spectrum as Background. O. Oldenberg and F. F. Rieke. *J. Chem. Phys.* 6. *pp.* 779–782, *Dec.*, 1938.—For the measurement of the concentration of OH radicals the intensity of the absorption spectrum is measured more easily with an *emission line* background than with a *continuous* background, provided that the pressure broadening is known. The total broadening of the OH absorption lines at 1473° K. and 1 atm. ($\frac{2}{3}\,O_2 + \frac{1}{3}\,H_2O$) is observed to be $0{\cdot}58$ cm^{-1}.; 36% of this value is Doppler broadening, the rest is pressure broadening. With this figure, recent intensity measurements of the OH bands by Avramenko and Kondratjew [see Abstract 211 (1938)] are reinterpreted. The resulting f values of approximately 3×10^{-4} are in reasonable agreement with the authors' previous measurements. The conditions are discussed under which the simple method using the line spectrum as a background is applicable. [For Part III see Abstract 3726 (1938).] AUTHORS.

310. Band Spectrum of Silicon Monosulphide. R. F. Barrow and W. Jevons. *Roy. Soc., Proc.* 169*A*. *pp.* 45–65, *Dec.* 6, 1938.—Previous work [see Abstract 4538 (1937)] suggested that SiS should possess a system of u.v. bands degraded to the red. In this paper details are given of its preparation and spectrum (absorption and emission). A vibrational analysis is given for an u.v. system of some 70–80 band heads whilst measurements are also given for a similar number of heads in the near u.v. and visible regions. The heads of the u.v. system fit the expression $\nu_{\text{head}} = 35028{\cdot}8 + (512{\cdot}0\ u' - 2{\cdot}38\ u'^2 - 0{\cdot}045\ u'^3) - (749{\cdot}5\ u'' - 2{\cdot}56\ u''^2)$, where $u = v + 1/2$. All the bands recorded are ascribed to the most abundant molecule $^{28}Si^{32}S$. It is possible that the near u.v. and visible system represents a second SiS system having neither state in common with the u.v. system. Finally, data for the system origins and vibrational coefficients for ten molecules of this subgroup of oxides and sulphides are discussed, for each molecule there being a system analogous to the fourth positive system $A'\Pi \rightarrow X'\Sigma$ of CO. The energy and products of dissociation of SiS are also considered. A. H.

311. Absorption Spectra of Acids of Elements of Sulphur Group. H. Ley and E. König. *Zeits. f. phys. Chem.* 41. *Abt.B.* 5. *pp.* 365–387, 1938.—The invalidity of Beer's law for dilute solutions of the sulphur acids may be explained on the assumption that the absorption is essentially due to more or less hydrated SO_2. The influence of H^+-ions and neutral salts on the absorption spectra of aqueous SO_2 solutions. which have a well defined maximum at 2750 Å, is investigated. Bisulphite, sulphonate and dithionate ions give only weak continuous absorption. Some acids and salts of 4- and 6-valent Se and Te are also investigated. C. B. A.

312. Absorption Spectrum of Br_2 Vapour in the Region 3400 to 2200 Å. R. G. Aickin and N. S. Bayliss. *Faraday Soc., Trans.* 34. *pp.* 1371–1374, *Dec.*, 1938.—In the quartz u.v. the absorption coefficient of Br_2 vapour, after passing through a minimum of 0·2 at 3000 Å, increases to a maximum of 3·5 at 2250 Å. By comparison with the absorption in the presence of added air, in liquid bromine, and in bromine solutions, the intensity is found to be very susceptible to the effect of perturbing influences. There is indication that the continuum is accompanied by a weak band system. AUTHORS.

313. Rotational Analysis of U.V. Bands of GeO. A. K. Sen Gupta. *Phys. Soc., Proc.* 51. *pp.* 62–68, *Jan.* 1, 1939.—From measurements on high-dispersion spectrograms, rotational structure analysis is made of the (1, 0) (2, 0) and (0, 3) bands of the u.v. band system of GeO. The bands are found to be due to a $^1\Sigma \rightarrow {}^1\Sigma$ transition and are thus analogous to the *A* bands of SnO and PbO, as has been suggested in a previous communication. Relevant molecular constants have been obtained for both the states. A few lines due to the less abundant isotopic molecules ^{70}GeO and ^{72}GeO have been observed in the (0, 3) band. [See Abstract 3100 (1937).] AUTHOR.

314. New Coriolis Perturbation in the Methane Spectrum. Part I. Vibrational-Rotational Hamiltonian and Wave Functions. Part II. Energy Levels. H. A. Jahn. *Roy. Soc., Proc.* 168*A*. *pp.* 469–518, *Nov.* 25, 1938.—In Part I the theoretically possible sublevels into which the rotational levels of a threefold degenerate mode of vibration of CH_4 can be split by a tetrahedrally symmetrical perturbation are given up to the tenth rotational quantum number, together with the correct vibrational-rotational wave functions with which to carry out the perturbation calculation. Good approximations to the true modes of vibration of the CH_4 molecule are given and used to evaluate certain Coriolis terms in the Hamiltonian which couple the twofold and threefold degenerate modes of vibration. The table given in the original, which gives the tetrahedrally irreducible harmonic functions and extends calculations of Bethe (1929) from the fourth to the tenth quantum number, will be useful in a number of connections. In Part II, using the vibrational-rotational wave functions derived in Part I, the perturbations of the rotational levels of the fundamental vibration ν_4 of the CH_4 molecule, caused by the Coriolis term in the Hamiltonian which couples the rotational levels of ν_4 with the rotational levels of ν_2, are calculated explicitly up to the tenth rotational quantum number. The table given in the original, which gives the wave functions for the tetrahedral rotational sublevels of ν_2, will be useful in calculating the perturbations of the rotational levels of any fundamental or overtone subvibrational level of symmetry type *E* n a tetrahedrally symmetrical molecule. [See also Abstract 4264 (1935).] AUTHOR.

315. Continuous Absorption Spectrum of Br_2 in Solution. C. L. Child and O. J. Walker. *Faraday Soc., Trans.* 34. *pp.* 1506–1515, *Dec.,* 1938.—The extinction coefficient curves for solutions of Br_2 in the following solvents have been determined : CCl_4, $CHCl_3$, CS_2, C_6H_6, $C_6H_5NO_2$, H_2O, CH_3COOH, C_2H_5OH. In inert solvents the main effect of the solvent on the Br_2 absorption band with λ_{max} 4150 Å is to increase the amount of absorption as compared with that of gaseous Br_2, without causing any marked change in shape or displacement of the extinction coefficient curve. In polar solvents the wave-length of maximum absorption is more or less shifted towards the u.v. In alcohol solutions the shift is comparable in magnitude with that found for the corresponding iodine solutions. The influence of the solvent in increasing the amount of absorption is discussed. AUTHORS.

316. Effect of Solvents on Continuous Absorption Spectrum of Bromine. R. G. Aickin, N. S. Bayliss and A. L. G. Rees. *Roy. Soc., Proc.* 169*A*. *pp.* 234–246, *Dec.* 22, 1938.—The visible and u.v. absorption spectrum of Br_2 has been investigated in the following solvents : water ($2N$ H_2SO_4), cylohexane, chloroform, carbon tetrachloride, benzene, chlorobenzene, toluene. The weak u.v. absorption of gaseous Br_2 is enormously enhanced in solution, particularly by the aromatic solvents. The smallest effect occurs in CCl_4, where considerable deviations from Beer's law were found. Absorption maxima in the u.v. were found at 2500 Å in cyclohexane, at 2725 Å in chloroform, and in the neighbourhood of 2950 Å in the aromatic solvents. In the region of the visible continuum, the non-aqueous solvents cause a marked increase in absorption intensity combined with a zero or small shift of the maximum towards the u.v. Water causes a large displacement (1750 cm.$^{-1}$) of the maximum to higher frequencies ; but only a very small increase in intensity. If the *A* component of the visible continuum is complex, the displacement of the maximum in non-aqueous solvents can be interpreted as due to a greater solvent effect on $^1\Pi_u \leftarrow {}^1\Sigma_g^+$ than on $^3\Pi_{o+u} \leftarrow {}^1\Sigma_g^+$. The transition $^3\Pi_{1u} \leftarrow {}^1\Sigma_g^+$ is less affected still. Difficulty is found in interpreting the observations if the *B* continuum is complex and *A* simple. AUTHORS.

317. Luminescence Spectra of Fluorites and Apatites. H. Haberlandt. *Akad. Wiss. Wien, Ber.* 147. 2*a*. 3–4. *pp.* 137–150, 1938.—The luminescence, absorption and arc spectra of a number of fluorites and apatites were studied. By comparison of the spectrograms of the natural minerals with those of synthetic preparations the amounts and natures of the activating impurities were estimated. In many cases a correlation was established between a blue-green thermoluminescence in fluorites, or a yellow fluorescence in apatites, and the presence of Mn. J. E.

318. Zeeman Effect in Argon Spectrum. J. B. Green and B. Fried. *Phys. Rev.* 54. *pp.* 876–883, *Dec.* 1, 1938.—New measurements on the Zeeman effect of about 140 lines of the spectrum of A have been completed, yielding g values for several complete configurations, in particular the $3p^56s$, $3p^57s$, $3p^54d$, and $3p^55d$, and several levels of the $3p^56d$. These have been compared with the g values calculated by means of quantum mechanics. In some cases the agreement is good, but g sums show discrepancies. These are discussed in detail. The measurements differ in several cases from those of other observers. Concrete evidence of the jj parentage of some of the levels is presented. AUTHORS.

319. Stark Effect in Rotation Spectra. S. K. Chakravorty. *Zeits. f. Physik,* 110. 11–12. *pp.* 688–691, 1938.—A discrepancy between the values obtained by the author [see Abstract 4224 (1936)] and by Manneback [see Abstract 1620 (1927)] for the term for second order Stark effect in rotation spectra is explained. C. B. A.

320. Origin of Continuous Raman Spectrum of Electrolytes. L. Giulotto. *N. Cimento,* 15. *pp.* 273–278, *May,* 1938.—The continuous Raman spectrum which appears in the immediate neighbourhood of the exciting Hg lines has been investigated in aqueous solutions of electrolytes. The intensity of the continuum is a function of the concentration and of the nature of the ions. It is shown that the intensity depends on the degree of hydration of the ions. The author concludes that the continuous Raman spectrum is caused by the vibrations in the molecular aggregates which constitute the hydrated ion. L. K.

321. Raman Spectra and Structure of Aqueous Solutions. T. G. Kujumzelis. *Zeits. f. Physik,* 110. 11–12. *pp.* 742–759, 1938.—Solutions up to concentrations of 5*N* are investigated. In general the ions alter the structure of the water, destroying the " H bridges " between the molecules to some extent. Intra-molecular bands between 300 and 1000 appear much stronger, especially with the anion, and they also show a structure in some cases. In general these bands run parallel with the deformation frequency 1645 which appears very sharp in $Ca(NO_3)_2$ solution. The first maximum of liquid water about 3200 is in general much weakened (except with ClO'_4, SO''_4, CO''_3, IO'_3), but the second, about 3400, is strengthened. With KI the first is doubled and the second disappears, and with ClO'_4 a third maximum appears at 3600. The effect of temperature and of ionic additions on water are entirely different, and of theories of " ordering," that of Cross appears most probable [see Abstract 4079 (1937)]. An attempt is made to account for the various phenomena in comparison with hydration, viscosity and mobility of the ions, and attention is drawn to the similarity between borate glasses and salines. D. R. H.

322. Vibrations and Structure of Ions of Type XO_3. T. G. Kujumzelis. *Zeits. f. Physik,* 110. 11–12. *pp.* 760–762, 1938.—The author compares his own measurements [see Abstract 4150 (1938)] with those of Shen, Yao and Wu [see Abstract 1694 (1937)]. New measurements on HIO_3 solutions give results agreeing with the latter. D. R. H.

323. Raman Spectra of Deuteroethyl- and Deuteroethylene-Bromides. M. de Hemptinne and C. Velghe. *Physica,* 5. *pp.* 958–960, *Dec.,* 1938. *In English.*—The Raman spectra of deuteroethyl- and deuteroethylene-bromides have been measured. Evidence for the existence of isomers is found in the case of deuteroethyl-bromides. AUTHORS.

324. Raman Spectra of Acetylenes. Part I. Derivatives of Phenylacetylene, $C_6H_5C \equiv CR$. M. J. Murray and F. F. Cleveland. *Am. Chem. Soc., J.* 60. *pp.* 2664–2666, *Nov.,* 1938.—The principal lines in the Raman spectra of 3-chloro-1-phenylpropyne-1, 4-chloro-1-phenylbutyne-1, 5-chloro-1-phenylpentyne-1, 3-bromo-1-phenylpropyne-1, 3-phenyl-2-propynol-1, 4-phenyl-3-butynol-1, and 3-chloro-1-phenylpropene-1 (cinnamyl chloride) are reported. Many other lines of very low intensity have been observed. Many of these are characteristic of benzene, monosubstituted benzenes, and compounds containing the $-CH_2-$ group. AUTHORS.

325. Raman and Infra-Red Spectra of Uranyl Salts, and Structure of Uranyl Group. G. K. T. Conn and C. K. Wu. *Faraday Soc.,* *Trans.* 34. *pp.* 1483–1492, *Dec.*, 1938.—The Raman spectra of aqueous solutions of uranyl nitrate, chloride and sulphate have been obtained. The infra-red absorption spectra of uranyl chloride and acetate have also been studied in the crystalline state from 4μ to 14μ. A discussion of the results and their bearing on the structure of the uranyl group is given. In particular, attention is drawn to the fact that care must be taken in correlating the structure of a triatomic group with the number of "valence electrons," a correlation which has been found to hold for several groups in which the central atom falls in the first short period of the periodic table. AUTHORS.

326. Application of Spectrophotometric Data in Printing Ink Industry. C. E. Foss. *J.O.S.A.* 28. *pp.* 386–389, *Oct.*, 1938.—Briefly describes the principal applications that have been made of spectrophotometric data for printing inks, indicating modifications in technique that have been introduced with the use of the Hardy spectrophotometer. R. C. F.

See also Abstracts 57, 185, 186, 253, 270, 371, 375, 379.

TRANSMISSION.

See Abstracts 272, 282.

VISION.

327. Thresholds and Supra-Thresholds of Seeing. M. Luckiesh and F. K. Moss. *Am. Illum. Eng. Soc., Trans.* 33. *pp.* 786–813, *Nov.*, 1938. —Various thresholds and supra-thresholds of seeing are defined. Four are thresholds of visibility which can be measured for any visual object or task under specific conditions. In addition, two supra-thresholds or optima are defined. One is maximal production of useful work or maximal achievement. The other is maximal ease of seeing which may also be described as maximal conservation of the human resources of the human being who does the seeing. Various physical, visual and human factors which influence visibility and seeing are briefly considered. Some are aids and others are hindrances. Among the controllable aids, light and lighting are discussed in terms of thresholds and supra-thresholds. Owing to the predominant importance of visibility, its measurement is further developed in connection with the authors' visibility meter. Two scales of visibility involving size and contrast, respectively, are discussed. A scale of visibility in terms of size is readily visualisable. However, a scale of visibility in terms of threshold contrast is not distorted by aberrations as the former is. It is also more suitable for representing any degree of visibility in terms of the maximum obtainable and has advantages in considering supra-threshold visibility. AUTHORS.

***328. Rotating Disc and Pigment Colours. A. Polack.** *Rev. d'Optique*, 17. *pp.* 239–243, *June–July*, 1938.—Describes a rotating disc fitted with coloured paper sectors and enabling colour matching measurements to be made. The instrument is designed for the clinical detection and classification of colour-vision defects. W. S. S.

329. Indirect Vision. Y. le Grand and E. Geblewicz. *Rev. d'Optique*, 17. *pp.* 257–274, *Aug.*, 1938.—The authors have found that a flickering patch of coloured light of high brightness rapidly loses its colour and appears white when viewed by indirect (extrafoveal) vision. The frequency of flicker must be below the critical frequency but not too low.

The effect occurs whatever the colour of the light but is not observed with foveal vision. With the aid of a comparison patch of white light the relative luminosities of coloured lights from different parts of the spectrum were determined in their flickering, "physiologically white" condition. The spectral luminosity curve so obtained has a maximum at about 500 $m\mu$ but is very asymmetrical with a broad bulge on the long-wave side. The luminosity curves for extrafoveal and foveal vision of steady lights were also determined for the same subjects. The interpretation of the results in terms of the rod and cone mechanisms, although promising at first sight, leads to difficulties. W. S. S.

330. Optics of the Eye and Vision of Contours. C. Lapicque. *Rev. d'Optique*, 17. *pp.* 297–318, *Sept.*, 1938.—Starting with the distribution of luminosity in the retinal image of a point source of white light, the author evaluates the luminosity across the retinal image of a dark or light band for various pupil sizes. The apparent contrast in the band and its apparent width are determined. It is shown that a band will cease to be visible when its apparent contrast is below 2%, whatever the original object contrast. The bearing of the results on vision in ordinary three-dimensional space and vision of pictures is discussed. W. S. S.

See also Abstract 276.

X-RAYS.

331. Hyperfine Structure of X-Rays. V. Dolejšek, J. Bačkovský and J. Faus. *Comptes Rendus*, 207. *pp.* 911–913, *Nov.* 14, 1938.—Sharp definition and high dispersion of X-rays reflected from crystals were obtained by making the photographic plate-crystal distance as small, and the slit-crystal distance as large as possible. With this arrangement, and using crystals of $CaSO_4$, NaCl, and ZnS, observations on the widths, sharpness, and structure of lines are reported and discussed in relation to penetration of the rays and crystal structure. N. M. B.

332. Plural X-Ray Reflection Methods. V. L. Bollman, H. H. Bailey and J. W. M. DuMond. *Phys. Rev.* 54. *pp.* 792–801, *Nov.* 15, 1938.—The possibilities of the plural reflection X-ray spectrometer for the study of crystal diffraction patterns are investigated with special reference to calcite. With Mo $K\alpha$ radiation, the work casts grave doubt on the applicability of the ideal flat-topped Prins pattern-profile to the real case. No asymmetry was observed in the peaks of the curves, but it is pointed out that the asymmetry to be expected on the Prins theory is so small that a vacuum plural spectrometer employing larger wavelengths would be necessary to detect it. A. G. Q.

333. Shape of Modified Compton Line for Hydrogen and Ceylon Graphite Scatterers. H. A. Kirkpatrick and J. W. M. DuMond. *Phys. Rev.* 54. *pp.* 802–808, *Nov.*, 1938.—H_2 under 10 atm. pressure was used to scatter almost directly backward the characteristic K-radiation of a Mo-target X-ray tube. After an exposure of 1914 hr. in a focusing curved-quartz-crystal spectrograph the resulting modified line was studied with a microphotometer. The breadth of the composite modified line of the α-doublet was 15·2 XU. This is 10% greater than the breadth computed by B. Hicks from the electron momentum distribution. That the discrepancy is greater for H_2 than for the previously studied He is probably because the H_2 calculations were not carried to so high a degree of approximation. The unmodified line was completely absent. The shift as determined by fluorescence reference lines is less than that required for free electrons by an amount appropriate to the binding energy of electrons in the H_2 molecule. A renewed search was made for evidence of any departure of the electron momenta from an isotropic directional distribution in Ceylon graphite, a diamagnetic crystal. This time the diamagnetic axis of the graphite was placed normal to the direction along which the experiment resolves the electron velocities. There was no indication of two lines or prominences symmetrically disposed on either side of the centre of the Compton line corresponding to shifts for the directly approaching and receding electrons. A small error in the previous determination of the shift defect for He is noted. [See Abstract 4579 (1937).] AUTHORS.

334. Characteristic Temperature of MgO. G. W. Brindley and P. Ridley. *Phys. Soc., Proc.* 51. *pp.* 69–72, *Jan.* 1, 1939.—The characteristic temperature of MgO is derived from measurements of the intensity of X-ray reflections at 86° and 293° K. The result obtained, $\Theta = 715° \pm 44$, agrees favourably with a recent determination by Ribner and Wollan [see Abstract 3288 (1938)], who give $\Theta = 743°$ K., a value which, they state, carries " a rather large probable error." AUTHORS.

335. X-Ray Investigation of Atomic Vibrations in Cadmium. G. W. Brindley and P. Ridley. *Phys. Soc., Proc.* 51. *pp.* 73–80, *Jan.* 1, 1939.—Measurements are made of the intensities of X-ray reflections from Cd powder at 86° and 293° K. Absolute values of the ratio I_{86}/I_{293} are obtained from comparative measurements on a composite specimen of Cd and Al powders. The results are discussed in relation to recent theoretical work regarding the effect of lattice vibrations in hexagonal metals on the intensities of X-ray reflections. It is shown that the lattice vibrations in Cd are considerably greater parallel to the *c* axis than in the basal plane. Values are calculated for the mean atomic displacements in different directions in the metal at 86° and 293° K., and the results are also expressed in terms of characteristic temperatures: Θ_0 (parallel to the *c* axis) = 107° and Θ_{90} (normal to the *c* axis) = $164°{\cdot}_5$ K. These results are compared briefly with similar results for Zn. AUTHORS.

336. Blackening of Photographic Plates by Long Wave-Length X-Rays. Part II. F. R. Hirsh, Jr. *J.O.S.A.* 28. *pp.* 463–465, *Dec.*, 1938.—Density-exposure time curves in the region of 11·0 to 14·0 Å are presented. A new linear relation between density and exposure time is shown which may prove useful to photographic workers. An empirical expression is obtained connecting density and exposure time. [For Part I see Abstract 3914 (1935).] AUTHOR.

***337. Focusing with the Seemann Edge. V. Dolejšek and M. Rozsíval.** *Comptes Rendus*, 207. *pp.* 786–788, *Nov.* 2, 1938.—The method as first worked out required a conically curved perfect crystal (gypsum, rock-salt and quartz cut perpendicular to the electric axis were tried) and a blunt Seemann edge, the source of X-rays being placed on the axis of the cone. A change in the position of the antikathode allowed the use of a cylindrically curved crystal, which is much more convenient. Results show that the width of the lines is not due to penetration of the radiation into the crystal, but to its imperfection. Quartz gave the best results. C. A. S.

See also Abstracts 267 and
112B. " Rotalix " X-Ray Tube. J. H. van der Tuuk.

HEAT.

CALORIMETRY.

338. Relation between Change of Density and Heat of Fusion at the Melting Point of Metals. A. Harasima. *Phys. Math. Soc. Japan, Proc.* 20. *pp.* 850–854, *Oct.*, 1938. *In English.*—A relation existing between the heat of fusion and the change of density of metals upon melting is obtained by the method of the virial theorem following Fröhlich. By the virial theorem the increase in energy upon melting is taken equal to the decrease in kinetic energy which results from the decrease in the Fermi energy upon melting. For alkali and noble metals the change of density is given by $5/(3\pi^2)^{2/3} \times mQM^{2/3}d^{1/3}/(h^2L^{5/3})$, or, numerically, $4 \cdot 20\ 10^{-3}\ QM^{2/3}d^{1/3}$, where Q is the heat of fusion in kg.cal./gm.atom, M the atomic weight and d is the density. AUTHORS.

CONDUCTION.

339. Heat Conduction in a Medium Composed of Several Layers. N. Malkin. *Comptes Rendus (Doklady) de l'Acad. des Sciences, U.S.S.R.* 20. 2–3. *pp.* 109–111, 1938. *In French.*—The equation of thermal conduction is taken in its vectorial form and is applied to a medium consisting of several layers defined by a family of surfaces which can be designated by a constant. The temperature is taken as a function of this constant and the heat transfer is worked out for generalised coordinates. The results are first obtained for each individual layer and then these are combined subject to certain boundary conditions. The solution is obtained in such a form that existing tables can be used for its evaluation. A large number of references is given together with a short discussion of some of the papers. E. H. D.

340. Influence of Magnetic Fields on Thermal Conductivity of NO and NO$_2$. H. Torwegge. *Ann. d. Physik*, 33. 5. *pp.* 459–470, *Nov.*, 1938.—Using Schleiermacher's method for the measurement of thermal conductivity an investigation is made of the influence of magnetic fields on this property for the paramagnetic gases NO and NO_2. The results obtained for NO are completely analogous to those of Rieger for 0_2. [see Abstract 2068 (1938)]. For both NO and O_2 the relative decrease in conductivity, $\epsilon = -\Delta\lambda/\lambda$ is equal to $A(H^2/p)$ where λ = thermal conductivity and $\Delta\lambda$ = the observed change, H = the field strength in gauss, p = the gas pressure in mm. of Hg, and A = a constant, having values of 3×10^{-4} and $0 \cdot 072 \times 10^{-4}$ for O_2 and NO respectively. For NO, ϵ reaches a maximum value equal to $0 \cdot 8\%$. The ratio $(\epsilon_{O_2}/\epsilon_{NO})$ decreases with increase of H/p to the limiting value of $1 \cdot 5$, the ratio of the corresponding magnetic moments. The measurements on NO_2 are carried out at 150° C. to avoid formation of N_2O_4 which is diamagnetic. The results differ from those for NO and O_2 in that ϵ approaches different saturation values for each pressure. This difference is thought to result from a secondary effect which requires further investigation. R. W. P.

341. Heat Conductivity of Frozen Moist Insulators. Z. Nagaoka A. Watanabe and Y. Yasiro. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 824. *pp.* 1034–1041, *Oct.*, 1938. *In English.*—The heat conductivity of heat insulators is increased by the frozen moisture in them. Especially such insulators as silicate cotton, glass-wool, and granulated cork are much affected. In those insulators, the fibre or granule does not absorb much water and their surfaces have little repulsive power on water, so the heat conductivity can be calculated approximately. Moisture, however, does not affect much the heat conductivity of such insulating materials as rice-hulls, cotton-cloth, cotton flannel, and wool felt. In such insulators, the fibre, thread, or granule absorbs much water or has a repulsive force on water. If granulated cork is made waterproof, the effect of moisture upon its heat conductivity is much reduced.

AUTHORS.

See also Abstracts 132, 148, 153, 382, 384, 389.

CONVECTION.

342. Thermoconvective Vortices Revealed by Condensation of Water Vapour. D. Avsec. *Comptes Rendus*, 207. *pp*. 565–567, *Oct*. 3, 1938.—Thermoconvective vortices were observed previously [see Abstract 1720 (1937)] in a cell, heated at the base, which contained dry air. Experiments are now described and photographs reproduced showing that similar air currents can be set up in air containing a high percentage of water vapour. The cell is partly filled with water and the vortices are made apparent by patches of condensed water on the cooler walls of the vessel. The form and motion of this condensation indicates that ascending air currents carry the moistest air. R. W. P.

See also Abstract
104B. Emissivity. W. Wilson.

DILATATION.

343. Thermal Expansion of Liquids. R. Lucas. *Comptes Rendus*, 207. *pp*. 900–901, *Nov*. 14, 1938.—The connection between the thermal expansion of liquids and their viscous properties is discussed. Representing the thermal agitation by longitudinal and transverse viscous waves, it is shown that the contributions α_t from the transverse waves and α_l from the longitudinal waves of low frequency to the expansion coefficient at constant pressure α, depend on $(\partial\eta/\partial p)_T$ where η is the viscosity, p the pressure and T the absolute temperature, and that these contributions may be negative. The longitudinal waves of high frequency always give a positive contribution, Bridgeman's values of $(\partial\eta/\partial p)_T$ for about 40 liquids show that α_t and α_l, and hence α are positive, but for water over a certain range $(\partial\eta/\partial p)_T$ is such that α is negative, thus explaining the anomalous expansion of water. For heavy water the experimental value of α is negative at temperatures below 11° C., and so it may be presumed that the viscosity of heavy water diminishes with increase of pressure within this region. [See Abstract 762 (1938).] S. W.

See also Abstract 446.

FUSION AND SOLIDIFICATION.

344. Electronic Lattice in Multiply-Ionised Compounds. R. Forrer. *J. de Physique et le Radium*, 9. *pp*. 411–418, *Oct*., 1938.—The relation $T = F\sqrt{N}$ [see Abstract 5386 (1937)] applied in the case of mono-ionised salts (KCl, etc.) is now applied to the cases of compounds such as CoO, VN, TaC, ZrC, etc., regarded as doubly, trebly or quadruply ionised, and finally to graphite, the factor F being now proportional to the degree of ionisation, while the contact electrons are furnished by substage p^6. C. A. S.

See also Abstracts 32, 67.

TEMPERATURE.

345. Thermodynamic Scale of Temperature. N. Kürti and F. Simon. *Phil. Mag.* 26. *pp.* 840–849, *Nov.*, 1938. *Supplement.*—Difficulties associated with the determination of temperatures attainable by the magnetic method are briefly discussed, and a method, proposed by the authors, for determining such temperatures, is described. The magnetic substance, previously cooled down in zero field, is supplied with a certain amount of energy per unit time, *e.g.*, by means of γ-rays, and the "temperature" (measured by a secondary thermometer, *e.g.*, the susceptibility of the substance) is plotted as a function of the time. An additional field (H) is switched on while heating is continued, then the field is switched off and heating is still continued. From entropy considerations, the ratio of $T_{(H)}/T_{(0)}$ is determinable in terms of time intervals only. The method is illustrated by an experiment carried out with iron alum. J. S. G. T.

346. "Curie" Scale of Temperature. N. Kürti and F. Simon. *Phil. Mag.* 26. *pp.* 849–854, *Nov.*, 1938. *Supplement.*—In the temperature region attained by the magnetic method, "temperature" is usually determined by measuring the susceptibility of the salt used and extrapolating in accordance with Curie's law (T^* scale). It is not practicable to establish the absolute scale in every case, and there appears to be a tendency to attribute a greater significance to T^* than is warranted. A method of defining T^* satisfactorily is suggested. The theory is given for a magnetisable salt in the form of an ellipsoid for which the ratio of length to dia. is p. The authors suggest the desirability of defining T^* as temperatures corresponding to the case of a sphere ($p = 1$). Values of $T^*_{p=1}$ can be calculated from results obtained with any ellipsoid. J. S. G. T.

347. New Method for Production of Extremely Low Temperatures. S. Zamenhof. *Acta Physica Polonica*, 7. 2. *pp.* 125–126, 1938. *In English.*—The author proposes a new non-magnetic method for production of low temperatures; the method has not as yet been tested experimentally. AUTHOR.

See also Abstracts 231, 334, 355.

THERMOCHEMISTRY.

348. Heats of Solution and Heats of Reaction in Liquid Ammonia. F. C. Schmidt, F. J. Studer and J. Sottysiak. *Am. Chem. Soc., J.* 60. *pp.* 2780–2782, *Nov.*, 1938.—A method is described for the extraction of pure Rb + Cs from their respective halides in good yields. The atomic heats of solution of K, Rb and Cs have been measured over a fairly wide range of concentrations and found to be zero. The atomic heats of solution of metallic Li, Ca, Ba and Sr have been measured over a range of concentrations and have been found to have a negative heat of dilution. [See Abstract 769 (1937).] AUTHORS.

349. Heats of Formation of Nitrides. S. Satoh. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 845. *pp.* 1356–1363, *Oct.*, 1938. *In English.*—The heats of formation of various nitrides and azides were tabulated against the atomic numbers of their constituent elements.

By means of this figure, the heats of formation of nitrides hitherto considered difficult to determine have been roughly predicted. The results obtained are as follows : $\frac{1}{2}(N_2) + [As] = [AsN] - 33\cdot9$; $\frac{1}{2}(N_2) + [Sc] = [ScN] + 75\cdot0$; $\frac{1}{2}(N_2) + \frac{3}{2}(Br_{2liq}\} = NBr_3 - 80\cdot3$; $\frac{1}{2}(N_2) + [Hf] = [HfN] + 78\cdot3$ kg.cal. AUTHOR.

THERMODYNAMICS.

350. Critical Phenomena. W. Świętosławski. *Acad. Polonaise Sci. et Lettres, Bull.* 6–7*A. pp.* 304–315, *June–July*, 1938. *In French.*—Description is given of arrangements whereby the critical state can be rendered stationary at will. By suitable adjustments of temperature the meniscus of a liquid may be caused to disappear. The phenomena called critical take place within a relatively wide interval of temperature and pressure. The temperature at which the vapour (under a pressure such that mist no longer appears when it is passed) is transformed into liquid without formation of mist is that which corresponds with the critical temperature. Methods are described for determining precisely the critical constants of substances which may then be used as standards in comparative measurements of the critical constants of various other substances. J. J. S.

351. Quantum-Mechanical Theory of the Equation of State. Law of Force of Helium. J. de Boer and A. Michels. *Physica*, 5. *pp.* 945–957, *Dec.*, 1938. *In English.*—Starting from a suitable expression for the potential of molecular interaction, the theoretical expression for the second virial coefficient B can be expressed in the form of a law of corresponding states, based on volume and temperature units derived from the molecular field. The influence of quantum mechanics is discussed by integrating the expressions for the quantum mechanical correction terms of B, given by Uhlenbeck and Beth and by Kirkwood, which are valid for high temperatures [see Abstract 4283 (1936)]. From comparison of these expressions for B, new values for the molecular field constants of He and H_2 are obtained. These values are compared with the figures of Lennard-Jones and the theoretical data of Slater, Kirkwood and Margenau for He. AUTHORS.

352. Low Temperature Properties of Gaseous Helium. H. S. W. Massey and R. A. Buckingham. *Roy. Soc., Proc.* 169*A. p.* 205, *Dec.* 22, 1938.—A correction. [See Abstract 4997 (1938).]

353. Molecular Heat, Heat of Evaporation, Entropy and Chemical Constant of Krypton. K. Clusius, A. Kruis and F. Konnertz. *Ann. d. Physik*, 33. 7. *pp.* 642–650, *Dec.*, 1938.—The triple point, molecular heats in the solid and liquid states between 63° and 123° Abs., the heat of evaporation at the normal boiling point, the calorific and statistical entropies, the vapour pressure constant and the chemical constant of Kr have now been evaluated, and the following table gives the most important of these results :

Heat of Evaporation		at $119\cdot9_3°$ Abs.	2158 ± 3 cal./mol.
Calorific Entropy	S_{therm}		$34\cdot64 \pm 0\cdot10$ Clausius
Statistical Entropy	S_{stat}		$34\cdot65$ Clausius
Vapour Pressure Constant j_p			$1\cdot29_2 \pm 0\cdot02_2$
Chemical Constant j_K			$1\cdot29_5$

By means of these data it is indicated that among the contradictory results for the vapour pressure curve of Kr the measurements of Keesom and his collaborators deserve preference. H. H. Ho.

354. Specific Heat of β-Brass. R. Eisenschitz. *Roy. Soc., Proc.* 168*A. pp.* 546–566, *Nov.* 25, 1938.—A theoretical investigation is made of the specific heat of β-brass. The following assumptions are made in the course of the calculation : (*a*) The interaction energies of the atoms vary with the square of change of volume ; (*b*) The energy minimum of the average of Cu-Cu and Zn-Zn energies are lying at higher volume than the minimum of Cu-Zn. The partition function at constant volume is calculated according to the theory of Bragg and Williams ; the corresponding partition function at constant pressure is obtained by taking an average over the variable volume. It is shown that the specific heat curve can be adjusted so as to give good agreement with experiment for temperatures below the maximum of specific heat. The theory of Bragg and Williams is applied to a lattice containing a finite number of atoms. By introducing this number agreement is obtained with the experimental slope of the C_p curve beyond the maximum. A theoretical estimate is made which justifies the introduction of this finite number. A general theorem of statistical mechanics is derived, according to which all thermodynamical quantities in physically realisable systems are analytic functions of the temperature. AUTHOR.

***355. Transformations of Energy and Mechanical Work of Muscles. A. V. Hill.** *Phys. Soc., Proc.* 51. *pp.* 1–18, *Jan.* 1, 1939.—The mechanical work which a muscle performs and the energy used are measured and the results are discussed in order to elucidate the nature of the biological mechanism concerned in muscle stimulation. The work done by a stimulated muscle is due entirely to its capacity for shortening under load. The load P is related to v the velocity of shortening of isotonic contraction of frog's muscle by the equation $(P+a)(v+b)=(P_0+a)^b$ where P_0 is the isometric tension and a and b are constants. From analogy with the extension of a stretched spring, this suggests that the internal resistance of muscle is proportional to $v/(v+b)$. An extremely delicate instrument for following temperature variations in muscle, is described. The constants a and b can be determined independently by measuring the heat of muscle shortening and the rate of energy liberation and the values so determined are the same as those found by fitting the equation to the purely mechanical observations of load and speed of contraction. The viscosity hypothesis of muscle shortening is therefore unnecessary. The equation given seems to apply, with the necessary change of sign, for muscle lengthening. The process of muscle relaxation is entirely irreversible. The optimum load for muscle contraction is about 3/10 of the maximum, the maximum efficiency is about 39 % ; the overall efficiency (including that of the recovery process) is about half this value. The most efficient speed is somewhat less than that at which the greatest power is developed. Muscle consists of a purely contractile part and a purely elastic part. The elasticity acts as a buffer against shocks. The nature of the shortening heat and the mechanism determining the rate of energy liberation under load are briefly discussed. J. S. G. T.

356. Transformations in Mixed Metallic Phases. G. Borelius. *Ann. d. Physik,* 33. 6. *pp.* 517–531, *Nov.,* 1938.—This paper deals with fluctuations and nuclear formation in supercooled phases, previous work [see Abstract 4658 (1937)] which was based on a thermodynamic treatment of meta-stability, being now continued. H. H. Ho.

357. Generalisation of Thermodynamic Potentials Deduced from Chemical Affinity. P. van Rysselberghe. *Comptes Rendus,* 207. *pp.* 845–847, *Nov.* 7, 1938.—It has been shown previously [see Abstract

772 (1936)] that in general no function $Z(x, y; n_1 \ldots, n_v \ldots n_c)$ exists such that its partial differentials with respect to n are equal to the Gibbs potentials μ^v. In the present mathematical paper the generalisation Z of these thermodynamic potentials has been obtained from the standpoint of the affinity $A(x, y; n_1 \ldots n_c)$ function of state of T. de Donder, whereby it is shown that the chemical potentials are not functions of state. The considerations now advanced hold also for systems which are the venues of several simultaneous reactions. H. H. Ho.

358. Entropy of Solution. I. M. Barclay and J. A. V. Butler. *Faraday Soc., Trans.* **34.** *pp.* **1445–1454,** *Dec.,* **1938.**—The entropies of vaporisation from dilute solutions of four solutes in acetone and seven solutes in ethyl alcohol have been determined at 25°. The values in acetone extend the linear relation between the entropy and heat of vaporisation from $\Delta H = 4$ to 10 kg.cal. The values in alcohol are appreciably higher than those in acetone for the same value of ΔH. It is pointed out that all the entropies of vaporisation of solutes from non-associated solvents now available, as well as those of pure non-associated liquids themselves, approximate to a single linear relation between the entropy and heat of vaporisation. This relation is shown to be equivalent to the known fact that the Trouton ratio (entropy of vaporisation at the boiling-point) is approximately constant tending to increase with the boiling-point. Dilute solutions and pure liquids thus obey the same relation. The abnormally high entropies of vaporisation of solutes from associated liquids are connected with the abnormal surface entropies of cavities in these liquids, indicated by deviations from the Ramsay-Eötvos relation. AUTHORS.

See also Abstracts 107, 108, 114, 334, 410.

VAPORISATION AND CONDENSATION.

359. Saturation Vapour Pressures of Solutions by Fontell's Method. P. E. Tahvonen. *Soc. Scien. Fennica, Comm. Phys. Math,* 10. 2. [11 *pp.*], 1938. *In German.*—Fontell's method [see Abstract 1769 (1926)] is used to determine how the saturation vapour pressure of the mixture $C_6H_6 - CCl_4$ depends on the concentration of the liquid phase at 20°, 30° and 50·15° C. Similar measurements are made for the mixture $C_4H_{10}O - C_6H_6$ at 20° C. Use of this method has enabled more accurate results to be obtained. The concentration was determined in terms of the refractive index of the mixture, but for mixtures which are changing rapidly in composition it is suggested that the concentration should be determined from simultaneous measurements of such properties as density and dielectric constant. R. W. P.

360. Vapour Pressure of Isotopes. K. F. Herzfeld and E. Teller. *Phys. Rev.* **54.** *pp.* **912–915,** *Dec.* **1, 1938.**—It is shown here that if all degrees of freedom in a vapour are nearly classical and if there is no association, the vapour pressure of the lighter isotope is always higher. If only the external degrees of freedom are nearly classical and the internal ones are in the lowest state, the coupling of purely harmonic vibrations has either no influence or tends probably to a further increase of the excess vapour pressure of the light isotope. Anharmonicity and the change in the van der Waals forces probably account for those cases in which the heavier isotope has the higher vapour pressure. AUTHORS.

ACOUSTICS.

361. Resonance in Truncated Cones. A. E. Bate and E. T. Wilson. *Phil. Mag.* 26. *pp.* 752–757, *Nov.*, 1938. *Supplement.*—The open-end correction, independent of the frequency in cylindrical pipes, varies in conical pipes with the frequency. When the cylindrical pipe terminates in a conical pipe of semiapical angle 1° to 2°, the end- correction disappears. For cones of large angle up to about 86° the correction, measured along the axis, is negative. The cone of angle 90° is a plane flange with a positive end-correction. Conical pipes with semiapical angle below about 10° and closed at the narrow end, have natural resonant frequencies, the wave-length being four times the slant height, including the appropriate correction for the open end. Conical ends above about 10° behave as conical flanges. [See also Abstract 2247 (1930).] G. E. A.

362. Photography of Airscrew Sound Waves. W. F. Hilton. *Roy. Soc., Proc.* 169*A*. *pp.* 174–190, *Dec.* 22, 1938.—An experimental technique has been developed for photographing the shock waves generated by an airscrew at all speeds above a certain critical speed. A modified form of spark photography was employed, and photographs were obtained for the first time of the airscrew sound wave system at tip speeds ranging from 0·83 to 1·2 of the velocity of sound. The photographs also reveal a tailing vortex from the blade tip, and an eddying wake behind the blade. These vortices and eddies are more distinct at high speeds than at low, but there is no definite lower limit to the speed at which they can be photographed. A method is given for calculating the pressure amplitude of these shock waves from measurements of the width of the image. The wave velocity has been calculated from the photographs, and is found to be slightly greater than that of small amplitude waves. A method of calculating the shape of the waves is examined, but no theoretical indication of a wave front at tip speeds less than the speed of sound is given, whereas a very definite wave front exists down to speeds as low as 0·85 of sound velocity. The problem of noise reduction in aircraft is discussed. AUTHOR.

***363. Supersonic Velocity in Gases. Part I. S. K. K. Jatkar.** *Indian Inst. of Science, J.* 21*A*. 22. *pp.* 245–271, 1938.—As a preliminary to the measurement of the velocity of supersonic sound in the vapours of organic compounds, a study is made of the aberrations of supersonic interferometers used to determine the wave-length. Curves are given showing the variation of anode current of the quartz oscillator with the position of the reflector and the irregularity of the positions of the peaks (corresponding to nodal planes) is pointed out. The causes of these irregularities are investigated; the best results are obtained when a somewhat narrow interferometer tube is used and the quartz is carefully positioned a little way away from the tube. Under these conditions the wave-length is said to be obtainable with an accuracy of 1 in 700. K. M. C.

364. Supersonic Analogy of Electromagnetic Field. D. Riabouchinsky. *Comptes Rendus*, 207. *pp.* 695–698, *Oct.* 24, 1938.—It is shown that the equations representing the supersonic motion of a perfect, compressible fluid can be reduced to the form of Maxwell's electromagnetic equations. The vibrations of the fluid particles tend to be orthogonal to the group velocity when the scalar value of the latter becomes large compared with the velocity of sound. W. S. S.

***365. Supersonic Source of Improved Design: Optical Studies of Supersonic Waves in Liquids. F. E. Fox and G. D. Rock.** *Rev. Sci. Instruments,* 9. *pp.* 341–345, *Nov.,* 1938.—After discussing the production of sound radiation suitable for supersonic interferometry in liquid media, a source is described in which a piezoelectric quartz plate mounted at a nodal plane for its pincipal vibration mode has one vibrating face exposed directly to the liquid media so that its motion may approximate that of a piston radiating into a semi-infinite medium. A review is given of some of the optical methods using continuous illumination that can be used in the investigation of supersonic radiation fields in liquids. Both progressive and standing sound wave systems are used with plane and divergent light. Photographs are included and bring out in a striking manner phenomena discussed in optics and acoustics. AUTHORS.

366. Supersonic Waves in Colloid Chemistry. K. Sollner. *J. Phys. Chem.* 42. *pp.* 1071–1078, *Nov.,* 1938.—A review dealing with the dispersion and coagulation of colloids by supersonic waves. The orientation of anisometric particles by the waves is also considered. A. J. M.

367. Transmission of Sound Between Rooms in Brick Building. J. E. R. Constable. *Phys. Soc., Proc.* 51. *pp.* 53–61, *Jan.* 1, 1939.—A detailed investigation has been made of the mechanism by which sound is transmitted between adjacent rooms in brick buildings. The relative importance of sound transmitted by the intervening partition and by the flanking walls and floors is deduced from measurements of their vibration, and it is shown that indirect transmission by the flanking walls and floors can be markedly greater than direct transmission through the intervening partition. It is shown, for example, that in one pair of average rooms the sound transmitted indirectly was about six times as much as that transmitted directly. A method of predicting the importance of the indirect trasmission in any given case is described. It is concluded that in average buildings there is probably no advantage to be gained by installing partitions of special construction having sound-reduction factors greater than 55 or 60 db. AUTHOR.

***368. Direct Recording of Pitch and Intensity of Sound. J. Obata and R. Kobayashi.** *Acoustical Soc. of America, J.* 10. *pp.* 147–149, *Oct.,* 1938.—A very brief illustrated description of an elaborate apparatus giving electrically a record of pitch, intensity and time of a sound. A standard intensity-level recorder is used together with an improved form of pitch recorder previously described by the authors. An example of a pitch- and intensity-record made with the apparatus is reproduced. W. H. G.

369. International Standard of Musical Pitch. G. W. C. Kaye. *Nature,* 142. *pp.* 820–821, *Nov.* 5, 1938.—In the past, there have been many standards of pitch and many changes in these. The London Philharmonic Orchestra in 1826 based the pitch of the note A in the treble clef on a frequency 433, and, 19 years later, on 455. In 1834 a conference of Physicists in Stuttgart decided on 440, and the figure 435 was legalised in France in 1859. In 1896, the Philharmonic Society adopted 439, and in 1927 the Army Council lowered the pitch in British Army bands from 455 to 439. In the United States, 440 is now universal. At a recent conference of 30 musical organisations at Broadcasting House, it was agreed that the British Standards Institution be asked to try to secure an international standard of musical pitch. The B.B.C. has adopted 439 provisionally.

The effect of temperature on the pitch of different instruments is also discussed. The oboe, often used as an orchestral standard, is unsuitable as such, and the piano or an elinvar tuning fork is much better. The temperature control of concert halls is now much improved. Also electric organs, with no temperature coefficient, are being tuned to 439 and 440. For reasonable hall conditions it is probable that a temperature at or near 20° C. or 68° F. will be acceptable, and an international conference on the whole question may be convened in 1939. G. E. A.

See also Abstracts 69 and

67B. Sound-Intensity Measuring Set. M. Kobayashi and T. Hayashi.

ELECTRICITY AND MAGNETISM.

ALTERNATING-CURRENT NETWORKS.

370. Measurement of Wave-Form at High Voltages. H. E. Linckh. *Phys. Zeits.* 39. *pp.* 727–735, *Nov.* 1, 1938. *From the Reichsanstalt.*—The description is given of a new method of measuring wave-form at high voltages. By means of a capacitance divider and a circuit tuned to the fundamental the proportion of the harmonics to the fundamental is determined from the figure on the screen of a kathode-ray oscillograph. By measuring the voltage across the tuned circuit the effective value of the fundamental at the high voltage can be calculated; so that together with the wave-form measurement a complete picture of the test voltage is obtained. Since accurate condensers, such as compressed gas condensers, are available for voltages up to 500 kV the method is applicable for the highest voltages. [See Abstract 1763 (1937).] L. E.

See also Abstract 404.

CONDUCTION AND DISCHARGE IN GASES.

***371. Arc between Electrodes of Fused Non-Metals. M. Pierucci and L. Barbanti-Silva.** *N. Cimento,* 15. *pp.* 265–272, *May,* 1938. Continuing previous work [see Abstract 1303 (1936)], examination is made of the spectra emitted by arcs between fused non-metallic electrodes. Photographs of the spectra are reproduced. In general, a high degree of luminosity is observed accompanied by much self-reversal of the lines. F. C. C.

372. Probe Method for Carbon Arc at Atmospheric Pressure. C. v. Fragstein and M. Arndt. *Ann. d. Physik,* 33. 6. *pp.* 532–564, *Nov.,* 1938.—The probe method for the investigation of discharges in gases consists in the introduction of a conductor into the discharge and the measurement of the e.m.f. and current of this conductor with respect to one of the electrodes. Conclusions may then be drawn with respect to potential, electronic temperatures, etc., and the method enables localisation at definite points in the discharge. The introduction of the test conductor, however, causes disturbances, the chief of which is thermal, a cooling zone being established around the test piece. For any theory of the current obtained by the probe method to be valid, the movement of the carriers in the cool zone must be known, the magnitude of this current being very sensitive to temperature. On this account all previous measurements have led to incorrect values of carrier concentrations and potentials. The experimental part of the paper is very full and comprehensive, and is illustrated by 16 diagrams. The method has proved to be particularly useful for low pressure discharges. H. H. Ho.

373. Starting of Hg-Vapour Discharge Tubes. C. Kenty. *J. of Applied Physics*, 9. *pp.* 705–713, *Nov.*, 1938.—The Cooper-Hewitt lamp is started by breaking a current in an inductive circuit by a special switch; the inductance causes a high voltage to be produced which is impressed on the main kathode pool and starts the arc. The initiation of the arc is attributed to a high electric field at the edge of the pool and any scheme causing the Hg to wet the glass at the edge at a number of points, such as baking carborundum powder on the glass, assists in the starting. After initiation the current rises rapidly to a maximum and then decreases owing to a deficiency of vapour caused by electrical clean-up on the walls; violent voltage surges are set up across the tube during this period before the arc finally settles down to a steady state when the vapour pressure has risen to its normal value. E. O. T.

374. Ionic Recombination in Air. J. Sayers. *Roy. Soc., Proc.* 169*A*. *pp.* 83–101, *Dec.* 6, 1938.—An experimental study has been made of the recombination of ions in air. It is found that, up to pressures of 1 atm., the recombination coefficient varies with pressure in a manner which is accurately predicted by the theory of J. J. Thomson; *i.e.*, the recombination coefficient varies proportionally with the pressure up to about 100 mm., thereafter varying less rapidly as the pressure is increased, until, at 1000 mm., the recombination coefficient becomes pressure-independent. The apparent variation of the recombination coefficient with the ionisation intensity, noted by other workers, has been confirmed and explained as being due to the formation, by the ionising rays, of complex molecules such as ozone, new experimental evidence in favour of this explanation being adduced. A number of subsidiary experiments have yielded detailed information concerning the nature of the recombination process, from which the inaccuracies in previous work on this subject may be appreciated. Using the new values of the recombination coefficient for air, it has been possible to calculate the equilibrium ion density and the electrical conductivity at various levels in the lower atmosphere. For this purpose the rates of ion production measured by Regener by means of sounding balloons have been employed. The results so obtained are shown to agree very closely with the direct measurements of the atmospheric conductivity made in the stratosphere ascent of *Explorer II* at South Dakota by Stevens and Anderson in 1935. AUTHOR.

375. Transition from Field Excitation to Thermal Emission in the Arc Light. E. Olsson. *Arkiv f. Mat. Astron. och Fysik, Stockholm.* 26*B*. 4. [4 *pp*.], 1938. *In German.*—The predissociation bands of Al are sensitive indicators for studying excitation conditions in the arc as the predissociation levels only appear in thermal emission [see Abstract 2116 (1937)]. From intensity measurements it is found that thermal radiation is insignificant in the core of the arc and below 100 mm. pressure but preponderates above 1 atm. pressure unless the arc is strongly cooled. At all pressures the aureole radiation is thermal and independent of the core. At intermediate pressures the core radiation is of mixed character. In this transition region intensity anomalies occur; these are described and discussed in detail. It is deduced that the life periods of anomalous lines are of the order 10^{-9} to 10^{-10} sec. compared with 10^{-13} sec. for ordinary predissociation lines. J. E. K.

376. Removal of Wall Deposits by H.F. Discharges. R. H. Hay. *Canad. J. of Research*, 16. *Sect. A. pp.* 191–205, *Oct.*, 1938.—When a h.f. discharge is maintained between external sleeve electrodes in a tube coated with a thin metallic film, the film is removed from some regions and deposited in others, to give patterns which vary with frequency, pressure, the nature of the gas carrying the discharge, the nature of the film, and the tube diameter. Frequencies of 3·0, 60, and 300 Mc./sec. have been used with discharges in air, N_2, O_2 and H_2, at pressures ranging from 0·07 to 3·5 mm. of Hg and with coatings of Ag and, in some cases, of S. Tubes of 18 and 38 mm. outside dia. were used with a standard electrode spacing of 8 cm. and an electrode width of 1 cm. Evidence is given that the removal is of two types: (i) local, taking place underneath the electrodes; and (ii) general, occurring adjacent to the positive column of the discharge. The cause of both types is found in the bombardment by positive ions: the local, or electrode, effect varies inversely as the pressure and the frequency; the general removal is independent of frequency, but varies directly as the pressure and the gas ion mobility, and inversely as the radius of the tube. In interpreting the results, use is made of the hypothesis that the h.f. discharge is in effect two d.c. discharges with the electrodes as kathodes and the positive column as an effective anode. Verification has been found in the alteration of the positive column, the Faraday dark space, and the negative glow, with pressure variation and the variation of electrode spacing, and in the reaction of the negative glow to a transverse magnetic field. Deposition regions are identified with the intersection of the negative glow and the tube wall, but no satisfactory explanation is offered for the fine structure sometimes observed in such regions. AUTHOR.

377. Abnormal Kathode Fall of the Glow Discharge. M. J. Druyvesteyn. *Physica*, 5. *pp.* 875–881, *Oct.*, 1938. *In English.*—In order to test the theory of the abnormal kathode fall given by v. Engel and Steenbeck, a large number of current-voltage measurements have been made in discharges in He, Ne, A, Kr, Xe, at different pressures and using graphite electrodes. Considerable deviations from the theory are found to occur, particularly in He and A. For large current values the value of dV/di is much larger in He and much smaller in A, than the theoretical value. Points of inflection are also found at high current densities. It is pointed out that the discrepancies between theory and experiment are probably due to the simplifying assumptions of the theory, such as the neglect of ionisation by positive ions, and of ionisation in the negative glow. The low value of dV/di in A can be explained by the ionisation by positive ions. The inflection points at high current densities may be due to the decrease in ionisation probability by electrons at high speeds. J. E. R.

378. Electrical Discharge in Argon. F. H. Newman. *Phil. Mag.* 26. *pp.* 719–722, *Nov.*, 1938.—Volt-current characteristics have been obtained for a probe placed near to the kathode in an A discharge under varying conditions of gas pressure and discharge current. Instead of being concave upwards, as in normal cases, the curves are concave downwards. This anomalous characteristic is attributed to the presence of a positive space-charge. The results are connected with the anomalous characteristics found by Emeléus and Brown in discharges in I_2, O_2 and He. The variation of the main discharge current with gas pressure at constant p.d. between kathode and anode has been investigated and at each p.d. the current showed a maximum at a certain pressure, this pressure increasing with the p.d. J. E. R.

379. Cæsium Discharge under Conditions of Nearly Complete Ionisation. F. L. Mohler. *Bureau of Standards, J. of Research,* 21. *pp.* 697–706, *Nov.,* 1938.—Measurements of the spectral-intensity distribution of the continuous recombination spectrum have been used to measure electron concentration, N_e, and electron temperature, T_e. Using radiation from a 1-mm. capillary tube viewed end on, it has been possible to extend measurements to a current density of 300 A at pressures up to 17 mm. With increasing current the intensity reaches a flat maximum, and this maximum increases as the square of the pressure. Above 0·3-mm. pressure T_e is independent of pressure and increases linearly with current. The observations agree quantitatively with the theory that the Cs in the capillary is in temperature equilibrium at a temperature T_e, and a pressure equal to the vapour pressure. Electrical measurements of T_e and N_e have been made in a 5-mm. tube with pressures ranging from 0·0045 to 0·3 mm. In this range T_e increases with decreasing pressure. The gas temperature is not in equilibrium with T_e, and N_e has a value which is higher than that corresponding to temperature equilibrium. AUTHOR.

380. Theory of Ignition of Long Positive Columns. R. Seeliger and K. Bock. *Zeits. f. Physik,* 110. 11–12. *pp.* 717–726, 1938.—Theoretical discussion of the ignition phenomena of long discharge tubes and experimental results are presented which show that the ignition of long positive columns depends on very complicated effects which at present are not sufficiently well understood. A satisfactory solution of the problems in question does not appear possible at present. The solution depends on the results of further research, which has already been put in hand. A. W.

***381. Anomalies in Mass-Spectrography. H. Lichtblau.** *Akad. Wiss. Wien, Ber.* 147. 2*a*. 3–4. *pp.* 101–116, 1938.—The origin of spurious traces which usually appear on the plate of a mass-spectrograph is investigated with Mattauch's instrument [see Abstract 1328 (1937)]. Four kinds of spurious effect are differentiated ; ghosts of the first and second kind, bands, and polarisation effect. Ghosts of the first kind appear in the vicinity of twice the mass of abundant ions and are ascribed to charge transfer phenomena in the space between electric and magnetic fields. Ghosts of the second kind appear in the neighbourhood of $^{12}C^{++}$, $^{14}N^{++}$ and $^{16}O^{++}$ and are due to charge transfer due to space charges in the cylindrical condenser. Bands which appear as the result of molecular decomposition in the connecting piece are described and the mode of formation is discussed. The polarisation effect is a broadening of lines after long use of the spectrograph; it is considered that it can best be ascribed in the instrument used to the formation of double electrical layers on the deflection plates. J. E. K.

382. Distribution Numbers of Electron Terms in a Partially Ionised Gas. K. H. Riewe and R. Rompe. *Zeits. f. Physik,* 111. 1–2. *pp.* 79–94, 1938.—Calculation of the term distribution numbers for Hg and H with the help of formulæ previously given by Planck for a partially ionised atomic gas shows that if the degree of ionisation is neglected, the order of magnitude of the results may be quite wrong. [See also Abstract 3163 (1937).] A. W.

See also Abstracts 218, 220, 221, 223, 427.

CONDUCTION IN SOLIDS AND LIQUIDS.

383. Kinetic Approach to Theory of Conductance of Infinitely Dilute Solutions, Based on "Cage" Model of Liquids. M. J. Polissar. *J. Chem. Phys.* 6. *pp.* 833–844, *Dec.*, 1938.—Attention is called to the disparity between the hydrodynamic model of an electrolytic solution and its physical counterpart. The "cage" theory of liquids is reviewed, and some of its equations are developed with the purpose of bringing to the surface the underlying assumptions. A quantitative comparison is carried out between the behaviour of an ion subject to Brownian motion and that of the placidly moving ion of the hydrodynamic theory. The conclusion is drawn that the tremendous difference between the two models casts doubt upon the validity of the hydrodynamic equations. The possibility is mentioned that the hydrodynamic theory, while giving fortuitously approximately correct values of ionic radii, may still be incorrect in its theoretical implications. Stress is laid on the desirability of a kinetic theory of electrolytic conductance. An approach to a kinetic theory is made, based on the cage model of liquids. In this method, the ionic migration is considered as the cumulative effect of a feeble, sporadic, but directed perturbation of the violent but random Brownian movement. The method leads to an experimentally substantiated relation between the diffusion and the conductivity of an electrolyte. It offers a plausible explanation of the high temperature coefficient of the slow-moving ions. For the ions of an infinitely dilute aqueous solution of KCl, the method yields the following data: Heat of activation for a cage-to-cage jump, 4230 cal.; frequency of cage-to-cage jumps, $1\cdot12 \times 10^{11}$ sec^{-1}.; frequency of oscillation within the cage, $8\cdot3 \times 10^{13}$ sec^{-1}.; average number of oscillations in each cage, 740. AUTHOR.

384. Reduction of Wiedemann-Franz Law to Absolute Form. L. Laboccetta. *Ricerca Scientifica.* 9. *pp.* 262–263, *March*, 1938.—The constancy of the ratio κ/σ in various metals has been expressed in one of the following forms derived from the electronic theory of conduction:—

$$\frac{\kappa}{\sigma} = \frac{\pi^2}{3}\left(\frac{R}{F}\right)^2 T \quad \text{or} \quad \frac{\kappa}{\sigma} = \frac{\pi^2}{3}\left(\frac{R}{e}\right)^2 T.$$

Apart from the absolute temperature T measured on the thermodynamic scale, and the geometrical factor $(\pi^2/3)$, there is nothing in the formulæ but the universal constants e and m. The author shows how these can be reduced to the forms

$$\frac{\kappa}{\sigma} = \frac{\pi^2}{27}\mu^2\beta^2 \quad \text{or} \quad \frac{\kappa}{\sigma} = \frac{\pi^2}{27}\left(\frac{\mu}{\phi}\right)^2 \beta^2.$$

In these no further dimensional factors appear but only the pure number $\pi^2/27$ and the ratios of the homogeneous quantities μ, β, θ, whose values remain the same irrespective of the system of units in which they are expressed. This shows the possibility of expressing the electronic charge e in terms of the mass m and the gravitational and cosmic constants G and ϕ. D. R. H.

385. Nature of Interatomic Forces in Metals. L. Pauling. *Phys. Rev.* 54. *pp.* 899–904, *Dec.* 1, 1938.—It has been generally assumed that in the transition elements (Fe, Co, Ni, Cu, etc.) the 3*d* shell is filled with ten electrons or is nearly filled, and that the *d* electrons make no significant contribution to the cohesive forces in metals. Evidence is presented here to show that about half of the *d* orbitals (2·56 of the total of 5) are involved in bond formation, through hybridisation with the 4*s* and 4*p* orbitals, and that the number of covalent bonds resonating among the available interatomic positions increases from one to nearly six in the sequence K, Ca, Sc, Ti, V, Cr, remains nearly constant from Cr to Ni, and begins to decrease with Cu. The remaining 2·44*d* orbitals, with very small interatomic overlapping, are occupied by non-bonding electrons which are mainly responsible for the ferromagnetic and paramagnetic properties of the metals. This point of view provides a qualitative explanation of many properties of the transition metals (including those of the palladium and platinum groups), such as interatomic distance, characteristic temperature, hardness, compressibility, and coefficient of thermal expansion, and it accounts satisfactorily for the observed values of the atomic saturation magnetic moments of the ferromagnetic elements Fe, Co and Ni and their alloys. It is also shown to provide a reason for the occurrence of the positive exchange integrals which give rise to ferromagnetism. AUTHOR.

386. Integral Equation of the Skin Effect. F. Lettowsky. *Ann. d. Physik,* 33. 4. *pp.* 300–314, *Oct.*, 1938.—A critical discussion is given of the calculations of various authors relating to the skin effect with a view to clearing up some obscurities and explaining contradictions. J. J. S.

387. Change in Resistance in Metals Due to Hydrostatic Pressure. K. Honda and T. Hirone. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 841. *pp.* 1292–1298, *Oct.*, 1938. *In English.*—The manifold types of changes in resistance in metals by the action of extra-high hydrostatic pressure, newly observed by Bridgman [see Abstract 2135 (1938)] are explained by the authors' theory previously published on the nature of free electrons. For many metals the results of calculation agree satisfactorily with those of the experiments, but for a few metals a further approximation for the calculation of mean free path of the free electrons is required; it is found that the results satisfactorily explain the new data. AUTHORS.

388. Temperature Variation of Resistance of Carbon and Graphite. L. J. Collier, W. S. Stiles and W. G. A. Taylor. *Phys. Soc., Proc.* 51. *pp.* 147–152, *Jan.* 1, 1939.—The variation with temperature of the electrical resistance of specimens of amorphous carbon and of Acheson graphite has been determined for temperatures between 0° C. and 900° C. The results obtained are compared with those recorded by other investigators. The work is to some extent complementary to that of Powell and Schofield [see following Abstract] who determined the thermal and electrical conductivities of the same materials between 750° C. and 2500° C. Two samples of Acheson graphite showed minima of resistance at about 390° C. and 430° C. respectively. AUTHORS.

389. Thermal and Electrical Conductivities of Carbon and Graphite to High Temperatures. R. W. Powell and F. H. Schofield. *Phys. Soc., Proc.* 51. *pp.* 153–172, *Jan.* 1, 1939.—The thermal conductivity K is derived in terms of the difference in temperature which, in the steady state, is set up between the axis and the surface of a rod or tube of the material when the latter is electrically heated in an evacuated enclosure. The electrical conductivity σ is derived in the course of the same experiment from measurements of the current flowing in, and the p.d. across, a length of the rod located near the centre. Solutions of the heat-flow equations are obtained for the case in which K and the electrical resistivity ρ are not constant but vary with temperature in a linear manner. Experimental results are given for a variety of carbon consisting of 80% of petroleum coke combined with 20% of lampblack at temperatures up to about 2000° C. and for Acheson graphite up to about 2700° C. Evidence for the graphitisation of carbon is obtained in that the results for this material at the highest temperatures tend to conform with those for graphite. At normal temperatures the Lorenz functions, $K\rho/T$ of carbon and graphite are respectively about 17 and 200 times as great as the value normally obtained for metals. The values, however, decrease rapidly with increase in temperature, and at 1700° C. the Lorenz functions of both materials are only about 4 times as great as those of metals. [See preceding Abstract.] AUTHORS.

390. Contact between Metal and Insulator or Semiconductor. N. F. Mott. *Cambridge Phil. Soc., Proc.* 34. *pp.* 568–572, *Oct.*, 1938.—When a semiconductor is placed in contact with a metal an electrical double layer is set up, either between the metal and the semiconductor or in the semiconductor itself. This paper gives a mathematical investigation of the width of this double layer under certain assumptions. Results are discussed in relation to NaCl in contact with Na, and to the Cu_2O rectifier. N. M. B.

391. Relaxation in Transitions between Supraconductive and Normal States. P. H. van Laer and W. H. Keesom. *K. Onnes Lab., Leiden, Comm. No.* 254*d. Physica,* 5. *pp.* 986–992, *Dec.*, 1938. *In English.*—The results of experiments with a new apparatus led the authors to conclude that the transition from the normal to the supraconductive state in a constant external magnetic field is also accompanied by a relaxation. A survey is given of the conclusions drawn from the whole of the authors' relaxation experiments, together with some numerical data. [See also Abstract 1808 (1936).] AUTHORS.

392. Reversibility of Transition Between Supraconductive and Normal States. P. H. van Laer and W. H. Keesom. *K. Onnes Lab. Leiden, Comm. No.* 254*e. Physica,* 5. *pp.* 993–998, *Dec.*, 1938. *In English.*—Experiments with a new apparatus led to the conclusion that in the transition from the normal into the supraconductive state no irreversible increase in entropy takes place and further that for pure metals the transition from the supraconductive into the normal state or vice-versa may be called reversible in the narrower sense as defined in this paper. AUTHORS.

393. Dispersion of Conductivity of Polyvalent Electrolytes in Aqueous Solution. J. P. van der Hammen. *Physica,* 5. *pp.* 833–844, *Oct.*, 1938. *In German.*—The difference between the experimental value of the increase of h.f. conductivity of polyvalent electrolytes and that given by the theory of Debye and Falkenhagen may be due to ionic association. The conductivity of triethylenediamine-cobaltiferricyanide in aqueous solution is particularly considered. Assuming that only the free ions contribute to the h.f. effect the calculated dispersion is too small. It is probable, however, that ionic pairs may give rise to an apparent increased h.f. effect owing to dipole absorption. A. J. M.

394. Conductance of Alkali Iodides in Dimethylamine. E. Swift, Jr. *Am. Chem. Soc., J.* 60. *pp.* 2611–2614, *Nov.*, 1938.—The conductances of dilute solutions of NaI, KI and LiI in dimethylamine have been measured. The results are qualitatively in accord with the Kraus and Fuoss theory. It was found that the Li ion is probably solvated by dimethylamine. AUTHOR.

395. Conductance and Ionisation Constants of Propionic and Normal Butyric Acids in Water. D. Belcher. *Am. Chem. Soc., J.* 60. *pp.* 2744–2747, *Nov.*, 1938.—Measurements are reported on the electrical conductance of solutions of propionic acid, sodium propionate, *n*-butyric acid, and sodium butyrate in water at 25°. From these are derived conductances and ionisation constants. The limitations of the extrapolation method for determining limiting conductances and ionisation constants of weak electrolytes are discussed. AUTHOR.

396. Conductivities of Mixed Nitrates. P. van Rysselberghe and G. Lee. *Am. Chem. Soc., J.* 60. *pp.* 2776–2779, *Nov.*, 1938.—Conductivities of twenty groups of binary mixtures of nitrates of uni-, di-, and trivalent kations have been measured at total equivalent concentrations ranging from ·1 to $5N$. All mixtures studied except those of chromium nitrate with cadmium and aluminium nitrates, exhibit conductivities lower than the values calculated from the simple mixture rule. The departure from the mixture rule increases with the difference of the conductivities of the pure salts. The behaviour of mixtures containing chromium nitrate and of those containing nitric acid is briefly discussed. AUTHORS.

See also Abstracts 152, 227 and
40B. Low-Reading Mean Voltmeter. J. Greig and H. N. Wroe.

DIELECTRICS AND CAPACITANCE.

397. Dipole Moments of Vapours of Diphenyl Ether and Derivatives. Revision of Oxygen Valency Angles. I. E. Coop and L. E. Sutton. *Chem. Soc., J. pp.* 1869–1872, *Nov.*, 1938.—From the electric dipole moments of diphenyl ether and *p*-substituted or *pp'*-disubstituted derivatives it is in principle possible to calculate values of the angle between the C-O valencies. If no account is taken of the effect of interaction between the substituent groups and the ether group, the values obtained vary greatly and are obviously unreliable. In an earlier communication a method of making an allowance for this was described, which when applied to measurements made in solution, gave a value of 128° ± 4°. Owing to the fact that the solvent may have a considerable effect on the value observed for a dipole moment, it appeared possible that further error in the angle would arise from this cause, although according to current theories of the solvent effect this should not be serious. In order to verify the angle value, the moments of diphenyl ether and a number of suitable derivatives have now been determined in the vapour phase, and they give a corrected value of 124° ± 5°, which is in satisfactory agreement with the earlier one. AUTHORS.

398. Dielectric Polarisation of Liquid Se. J. Wesołowski. *Acad. Polonaise Sci. et Lettres, Bull.* 6–7*A*. *pp.* 290–303, *June–July*, 1938. *In German.*—By means of a condenser arrangement resembling that described by Jagielski the dielectric constant of liquid Se was measured in the region of temperature of about 235° to 300° C. Above the latter temperature the conductivity increases so quickly and the losses rise so much that the method employed becomes unsatisfactory. From the results obtained it appears : (1) In the temperature region considered the dielectric constant of liquid Se is linearly dependent on the temperature ; (2) The specific dielectric polarisation is within the limits of error independent of the temperature and is on the average $0 \cdot 1515 \pm 0 \cdot 001$; (3) The

product of the specific polarisation and the atomic weight gives the so-called " atomic polarisation " which was found to be $12 \cdot 00 \pm 0 \cdot 1$.
J. J. S.

399. Dielectric Polarisation and Formation of Intermolecular Complexes in Solution. D. L. Hammick, A. Norris and L. E. Sutton. *Chem. Soc., J. pp.* 1755–1761, *Nov.*, 1938.—The method recently employed by Earp and Glasstone [see Abstract 1420 (1937)] for the determination of association constants and dipole moments of complexes between donor and acceptor molecules, by measuring the dielectric polarisations of binary mixtures, has been investigated further. Modifications of the method have been suggested and examined, and it has been concluded that measurements of this kind alone cannot be expected to give conclusive results. To do this, it seems that the measurements must be combined with independent measurement of the equilibrium constant, and possible methods have been indicated. AUTHORS.

400. Specific Inductive Capacity of Diamonds by Method of Mixtures. S. Whitehead and W. Hackett. *Phys. Soc., Proc.* 51. *pp.* 173–186; *Disc.*, 187–190, *Jan.* 1, 1939.—The specific inductive capacity of diamonds in bulk has been measured by the method of mixtures, the most accurate single determination being 5·66 at 27·8° C. and 800 ∼. A general mean value of 5·7 applies within a standard error of 1·5% over the range of temperature from − 65° C. to + 85° C. and from 300 to 3000 ∼ and within a standard error of 3·2% for a frequency range from 50 to 5000 ∼ while no change within a standard error of 2% was observed up to 1·6 Mc./sec. Reasons are given for supposing the present value more accurate than those hitherto obtained, and it is also shown that the value deduced agrees satisfactorily with the refractive index on the basis of Maxwell's law and shows consistency with the relationships of specific inductive capacity to atomic number and the periodic table which hold for other elements. Some observations are made on other physical properties of the diamond and on the theory of the specific inductive capacity of mixtures. AUTHORS.

401. Dielectric Constant of Fused and Crystalline Quartz at Low Temperatures. D. Doborzyński. *Acad. Polonaise Sci. et Lettres, Bull.* 3–5*A*. *pp.* 153–168, *March–May*, 1938. *In German.*—Describes measurements of the dielectric constant of fused and crystalline quartz over a temperature range of + 18° to − 190° C. For fused quartz and crystalline quartz cut perpendicular to the optical axis, the dielectric constant—temperature curve shows a minimum at temperatures of − 70° and − 90° C. respectively. In the case of crystalline quartz cut parallel to the optical axis, the dielectric constant decreases slightly from + 18° to − 20° C., after which it remains practically constant. [See Abstract 2573 (1938).] E. R.

402. H.F. Dielectric Losses. T. Akahira, M. Kamazawa and Y. Nakajima. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 840. *pp.* 1280–1291, *Oct.*, 1938. *In English.*—In the measurement of the loss angle by the method of ordinary substitution, the effect of inductance and capacity of the lead wires and the effect of stray electromagnetic coupling are remarkable as the frequency increases. In order to eliminate these errors, the use of the " symmetrical substitution method " is proposed, in which the standard high resistances for high frequencies are conveniently used. Measurements on several insulating materials show that the accuracy of this method is about $\pm 1 \times 10^{-4}$ in tan δ at the frequency range of 100 kc ~ 10 Mc./sec. The effect of relative humidity on the results of the measurement is so remarkable that it must always be taken into consideration. AUTHORS.

403. Behaviour of Polar Molecules in Solid Paraffin Wax. R. W. Sillars. *Roy. Soc., Proc.* 169*A*. *pp.* 66–83, *Dec.* 6, 1938.—The experiments described constitute an extension of previous work by Jackson [see Abstract 2721 (1935)] and were carried out on solid samples of paraffin wax containing small concentrations of various long-chain esters. The esters are of molecular type similar to the wax, but have a permanent electric moment in virtue of the ester group. Dipole effects similar to those found by Jackson are observed and the variations of the characteristic time constants with temperature and with chain length of the esters are studied. Variation with temperature is approximately exponential, the exponent being about the same for each ester. It is found that the time constant is a non-linear function of the total chain length of the ester molecule, but is relatively independent of the position of the ester group in the chain. It is confirmed that the observed losses are due to dipole effects and not to some adventitious cause. It is concluded that the whole ester molecule contributes to the time constant, and therefore that it behaves as a rigid structure and does not simply become deformed in the immediate neighbourhood of the dipole group. This is in agreement with evidence from other sources. The results do not suggest any simple relation between chain length and time contant, and a satisfactory theory to relate them has yet to be found. AUTHOR.

404. Precision Measurement of Capacitance. N. F. Astbury and L. H. Ford. *Phys. Soc., Proc.* 51. *pp.* 37–52, *Jan.* 1, 1939.—The paper describes a method for the measurement of capacitance in terms of mutual inductance and resistance. The circuit is developed from the Carey-Foster bridge, and a combination of two bridge circuits used successively leads to the elimination of small correcting terms. The power factor also of the condenser under test is determined. The values of capacitance and power factor are deduced entirely in terms of two readings of a mutual inductance and two readings of a resistance box. The screening of the bridge, including the mutual inductance, has been carried out in great detail, and the whole circuit is enclosed in an earthed screen within which certain of the components are again screened independently. The effects of stray capacitances within the network and between the network and earth are thus reduced to negligible proportions. The equipment is designed for measurements on capacitances ranging from 1000 $\mu\mu$F to 2 μF at frequencies ranging from 50 to 3000 ~, and the probable errors are estimated as 5 parts in 10^5 on capacitance and 0·00005 on power factor at 1000 ~. At higher frequencies and for capacitances outside the stated range, the accuracy may be halved. The circuits are very adaptable and the bridges, as finally constructed, can be used also for the measurement of self-inductance and other quantities. AUTHORS.

See also Abstracts 9, 10, 449.

ELECTROCHEMISTRY.

405. Electrochemistry of Niobium. G. Grube and H. L. Grube. *Zeits. f. Elektrochem.* 44. *pp.* 771–780, *Nov.*, 1938.—The electrolytic reduction of $NbCl_5$ was examined in HCl, and in H_2SO_4 solution, using Hg electrodes. In both cases the current yield was highest with c.d. 0·001 A/cm². The oxidation-reduction potentials of the reaction

Nb^V/Nb^{III} (0·02 N in Nb) in 1·01, 2·03, 4·1, and 6-*N* HCl, was − 0·359, − 0·324, − 0·296 and − 0·269 respectively, and in 6·2, 8·18, 9·9 and 12·5*N* H_2SO_4, − 0·347, − 0·336, 0 —·310, and − 0·313. The potential-determining reaction in both cases is $Nb^{III} + H_2O \rightleftharpoons NbO^{III} + 2H^{\cdot} + 2\ominus$, of which the normal potential at room-temperature in HCl is − 0·344 ± 0·002, and in H_2SO_4 − 0·342 ± 0·001. Evidence was obtained that in HCl solution an unstable product of further reduction, perhaps to Nb^{11} was produced. C. A. S.

406. First Thermodynamic Ionisation Constant of D_2CO_3. J. Curry and C. L. Hazelton. *Am. Chem. Soc., J.* 60. *pp.* 2773–2776, *Nov.*, 1938.—The ratio of the first thermodynamic ionisation constants of proto- and deuterio-carbonic acid has been determined potentiometrically using a cell without transference in which the electrodes were quinhydrone and Ag-AgCl. Using 99·1% D_2O the ratio, K_H/K_D, has been found to be 2·68 at 25°. AUTHORS.

407. Dissociation of Ammonium Ion and Basic Strength of Ammonia in Water. D. H. Everett and W. F. K. Wynne-Jones. *Roy. Soc., Proc.* 169*A*. *pp.* 190–204, *Dec.* 22, 1938.—The dissociation of NH_4 in water has been measured at 10° intervals from 5° to 45°. The results can be represented by the equation $-\log K_{NH_4+} = 2706/T + 0{\cdot}139$. Values of the constant for the equilibrium $NH_3 + H_2O = NH_4^+ + OH^-$ have been derived from these results by combining them with the data for ionic product of water. At 25° K_{NH_3} is $1{\cdot}65 \times 10^{-5}$. The heat of dissociation of NH_4^+ as calculated from the temperature coefficient of the dissociation constant is 12,400 cal. The temperature dependence of dissociation constants is related to the electrical type of the chemical reaction and, from the fact that simple electrostatic considerations do not account for the results, it is concluded that strong orientation of the solvent molecules occurs. AUTHORS.

408. Equation for Transference Numbers. T. Shedlovsky. *J. Chem. Phys.* 6. *pp.* 845–846, *Dec.*, 1938.—The following transference number equation is proposed, $1/t = 1/t_0 + AC^{\frac{1}{2}} - BC$. The values for the constant A are in accord with the Onsager theory for most uni-univalent electrolytes in water, but not for abnormal salts, such as $AgNO_3$, or for higher valence salts. However, the transference equation appears to have quite general applicability. AUTHOR.

409. Metal-Metal Oxide Electrodes. Part I. W and Mo Electrodes. C. T. Abichandani and S. K. K. Jatkar. *Indian Inst. of Science, J.* 21*a*. 29. *pp.* 345–361, 1938.—The behaviour of polished W and Mo wire electrodes has been studied over a pH range 2–12 in an atmosphere of H_2. It has been shown that a W electrode gives a theoretical relationship of pH and e.m.f. over a range of pH 2·8 to 9·4, and a Mo electrode over a short range from pH 5 to 7. Experiments have also been made in atmosphere of air and O_2, when the electrodes deviated very much from the theoretical relationship. Temperature coefficient of the system Pt ; H_2 | solution pH || WxOy | W has been measured and the values for free energy and heat of formation of various oxides calculated. The calculated data agrees well with the heat of formation of tungsten trioxide on the surface of the metal. AUTHORS.

410. Thermodynamics of Double Electrodes with Two Unrestrained Ionic-Transferences in the Currentless State. E. Lange and K. Nagel. *Zeits. f. Elektrochem.* 44. *pp.* 792–813, *Nov.*, 1938. —The thermodynamic theory of the behaviour of the double electrode is reviewed and developed. The various types of electrode reactions and ionic changes are considered, in the light of the theory. F. J. B.

411. Streaming of Electrolytes in Reduction at the Hg Drop Electrode. H. J. Antweiler. *Zeits. f. Elektrochem.* 44. *pp.* 831–840, *Nov.*, 1938.—The current-voltage curves of solutions during electrolysis are determined, and the results discussed. The so-called " stirring effect " was investigated, and the mechanism of streaming of the electrolyte was qualitatively indicated. The streaming in a drop of water was kinematically photographed. The significance of the results in analytical chemistry is discussed. F. J. B.

412. Standardisation of Hydrogen Ion Determinations. Part II. D. I. Hitchcock and A. C. Taylor. *Am. Chem. Soc., J.* 60. *pp.* 2710–2713, *Nov.*, 1938.—Measurements of e.m.f. at 38° are reported for cells of the type H_2, buffer or acid solution, KCl (satd.), HCl ($0{\cdot}1N$), $H_2(+)$. Acetate, phosphate and borax buffers were used, as well as solutions of HCl with and without an added chloride. On the basis of the thermodynamic dissociation constants of the buffer acids and a nearly linear extrapolation, a value of E_0 was obtained for the reference electrode: KCl (satd.), HCl ($0{\cdot}1N$), H_2. On this basis pH values for 38° were assigned to several standard solutions, including $0{\cdot}1\ N$ HCl (pH 1·082) and $0{\cdot}1\ N$ acetic acid in $0{\cdot}1\ N$ sodium acetate (pH 4·655). These pH values, without correction for liquid junction potentials, serve to establish a pH scale which may be used to obtain the values of thermodynamic dissociation constants at 38°. [For Part I see Abstract 5442 (1937).] AUTHORS.

413. Determination of Dissolved O_2 by Dropping Hg Electrode, with Applications in Biology. H. G. Petering and F. Daniels. *Am. Chem. Soc., J.* 60. *pp.* 2796–2802, *Nov.*, 1938.—A method using simple apparatus is described for measuring the concentration of dissolved O_2. A dropping Hg electrode is used and galvanometer deflections are measured at two predetermined voltages. The deflections are plotted against solutions of known concentrations giving a calibration curve which is a straight line. The limitations of the method are pointed out and the method is illustrated with the photosynthesis and respiration of algæ and with the respiration of yeast and blood cells and with animal tissue. AUTHORS.

414. Kinetics of Electrode Reactions. Parts I and II. J. N. Agar and F. P. Bowden. *Roy. Soc., Proc.* 169*A*. *pp.* 206–234, *Dec.* 22, 1938.—In Part I three main causes of irreversibility in electrode reactions are distinguished, *viz.*, concentration-, activation- and resistance-overpotentials. A general theory of concentration overpotential is developed, and this shows how the overpotential will depend on the current density, concentration and temperature. An expression for the rate of growth of concentration overpotential after switching on the current is also given. It is shown that the resistance of the diffusion layer may in some cases attain high values, and cause a resistive potential drop at least as great as the concentration overpotential. Finally, the principal differences between concentration- and activation- overpotentials are described. In Part II measurements of the O_2 overpotential on Ni and Pt electrodes in fused NaOH have been made. The current densities used ranged from very low values up to 1 A/cm². At the highest current density the overpotential is of the order 0·2V. Although in some respects the observations might suggest that the overpotential is of the same kind as that observed in the deposition of OH′ ions in aqueous solutions, the evidence as a whole shows that this is not so. The overpotential in fused NaOH is due to the change in the *concentration* of *water* in the melt in the immediate vicinity of the electrode. A small trace of water is normally present in the fused hydroxide, and more water is produced by the anode reaction. This view is supported by many different lines of evidence, including : (*a*) The influence of stirring the electrolyte ; (*b*) The effect of adding small quantities of water ; (*c*) The rate of increase of the overpotential on switching on the current ; (*d*) The nature of the relation between overpotential and current density ; (*e*) The low value of the temperature coefficient ; (*f*) The fact that the overpotential is independent of the nature of the electrode. The general behaviour is consistent with the theory of concentration overpotential developed in Part I. AUTHORS.

415. New Forms of Electrode Equations for the Analysis of Redox Titration Curves. A. Geake. *Faraday Soc., Trans.* **34.** *pp.* **1395–1409,** *Dec.,* **1938.**—New electrode equations are given for redox systems in which semiquinone formation occurs with or without precipitation of the quinone, and for mixtures of two simple systems. These are shown to have some practical advantages over the older equations. These are used to evolve simple methods for the calculation of semiquinone formation constants and the normal potentials of mixed redox systems. AUTHOR.

416. Anodic Behaviour of Cr. R. H. Roberts and W. J. Shutt. *Faraday Soc., Trans.* **34.** *pp.* **1455–1469,** *Dec.,* **1938.**—The behaviour of Cr anodes in acid chloride and sulphate solutions has been investigated oscillographically. If the high anodic voltage, associated with chromate formation, be regarded as indicating passivity of the metal, then the process of anodic passivation of Cr is found to possess many features in common with the behaviour of Au and Fe during passivation. A limiting current density C_0, whose value depends upon temperature and composition of electrolyte, must be exceeded before anodic passivation can take place, and, at any higher current, C, the time required for passivation (t sec.) is given by the relation $(C - C_0)t = X$ where the constant X is the coulombs required for passivation. Under certain conditions passivation takes place in three well-defined stages. The times required for completion of these stages have been measured and their significance discussed. Both spontaneous recovery of activity in acid media and the forced recovery of kathodic reduction have been examined. In HNO_3 or neutral salt solutions, Cr passivates instantly, on application of the smallest anodic currents, and kathodic reduction shows that, in such solutions, Cr carries a single molecular layer of oxide. The reactions $Cr \rightarrow Cr^{++} + 2 \ominus$ and $Cr \rightarrow Cr^{++++++} + 6 \ominus$ have been examined with reference to Faraday's law and the discrepancies are discussed. The above experimental results are shown to lead to the view that the first effect of electrolysis is the reduction of the concentration of H-ion immediately in contact with the anode ; this is followed by discharge of OH-ions and the formation of an oxide layer whose precise thickness and composition depend upon the conditions of its formation. AUTHORS.

ELECTRONS, NEUTRONS, POSITRONS AND PROTONS.

417. Concept of Axiality of Structure of the Electron. J. Stark. *Phys. Zeits.* **39.** *pp.* **735–736,** *Nov.* **1, 1938.** *From the Reichsanstalt.*—It is pointed out that the essentials of the author's present concept of the electron as a ring-like body in which electromagnetic energy and electric charge participate in a rotatory motion around an axis were advanced as long ago as 1907 in a paper in which Planck's constant was for the first time associated with motion of the individual electron. The author's experimental investigations since then have been based on this concept and have led to confirmation and further development of it. Essentially the same fundamental idea was advanced independently in 1915 by A. L. Parson in his magneton theory of the atom, was amplified by A. H. Compton in 1921 by adding a rotary mechanical moment of h/2π to the electron and was further developed in 1925 by Uhlenbeck and Goudsmit who attributed a spin to the electron. J. E. K.

418. Positron Spectrum of Active Thorium Deposit. A. I. Alikhanov and V. P. Dželepov. *Comptes Rendus* (*Doklady*) *de l'Acad. des Sciences, U.S.S.R.* 20. 2–3. *pp.* 113–114, 1938. *In English.*—Determination of this spectrum [see Abstract **3337** (**1936**)] was repeated with a more powerful source. The curves obtained show, besides the break at 1600 ekV, six smaller but well-marked discontinuities, from the γ-lines emission of which is thus indicated, it is inferred that the whole spectrum of the active Th deposit may be completely explained by inner conversion of γ-rays. Ellis and Mott's results [see Abstract **1832** (**1933**)] are confirmed. C. A. S.

419. Positron Spectrum Emitted by Lead Irradiated by γ-Rays of Th C″. A. I. Alikhanov and V. P. Dželepov. *Comptes Rendus* (*Doklady*) *de l'Acad. des Sciences, U.S.S.R.* 20. 2–3. *pp.* 115–116, 1938. *In English.*—Determination of this spectrum [see Abstract **3337** (**1936**)] was repeated with a much more powerful source and improved experimental conditions, using Pb foils 30 and 17 mg./cm^2. The small difference between the curves obtained in the two cases indicates that the true positron spectrum is little distorted by the finite thickness of the absorbent. The results agree with Egert and Holm's calculated curve. C. A. S.

420. Representation of Elementary Particles by Models. F. Renner. *Naturwiss.* 26. *pp.* 736–738, *Nov.* 11, 1938.—The author develops a model of the electron, consisting of a rotating ring of negative charge which gives the correct ratio of magnetic to mechanical moment and for which the product of the errors in determining position and impulse would be of the order required by the indeterminacy principle. For the neutron model, concentric rings of opposite charge, and for the proton model, either a single positive ring or three concentric rings are proposed. W. S. S.

421. Magnetic Separation of Charged Particles in an Inhomogeneous Magnetic Field. J. Thibaud. *N. Cimento,* 15. *pp.* 313–342, *May,* 1938. *In French.*—The methods for separating particles, *e.g.*, from nuclear disintegrations, of different charges or different energies are discussed and the method depending on the use of an inhomogeneous magnetic field is considered in detail and compared with the other methods. The apparatus is described and several applications are quoted, among them being experiments on the absorption of particles, the study of secondary radiations, artificial radioactivity, and the natural β-ray spectra. It is suggested that the method might be employed for the determination of e/m for fast particles such as β-rays (positive and negative electrons). C. J. B. C.

422. Charge and Magnitude of Individual Particles. F. Ehrenhaft. *Phys. Zeits.* 39. *pp.* 673–687, *Oct.* 1, 1938.—A detailed review is given of the long series of investigations by the author, his collaborators and others on the existence of particles carrying charges smaller than that of the electron. Charges down to 2×10^{-11} e.s.u. have been observed in experiments by Millikan's method using particles of Au, Ag, Pt, Se, etc. of radius below 3×10^{-5} cm. (Millikan's result for the electronic charge, $4 \cdot 77 \times 10^{-10}$ e.s.u., was obtained with oil drops of radius greater than 4×10^{-5} cm.). Various ways in which the low values of the charge might appear as artifacts of the experiment have been extensively studied. In the latest work, individual particles which had been observed in the main experiment were captured and their radii determined by u.v. optical methods; the same methods revealed that the particles (Se) approximate closely to spheres. The validity of the modified Stokes law has been tested by experiments at pressures ranging up to 30 atm. The final conclusion is that microscopic and submicroscopic particles of spherical form have been shown to carry charges which are much smaller than the accepted electronic charge. W. S. S.

423. Most Probable Values of e, e/m, h. K. Shiba. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 843. *pp.* 1308–1321, *Oct.*, 1938. *In English.*—In continuation of previous work [see Abstract 4250 (1933)], the author correlates values deduced from e, e/m, $e^{-5}(e/m)\ h^3$, $e^4(e/m)^3h^{-3}$, $e^2(e/m)^3$, $e^{-3}h^3$, $e^{-4}h^3$ methods, with special attention to data published within the last five years. After suitable weighting he obtains the following values: $e = (4 \cdot 8025 \pm 0 \cdot 02\%) \times 10^{-10}$ c.g.s. e.s.u., $(e/m) = (1 \cdot 7589 \pm 0 \cdot 02\%) \times 10^7$ c.g.s. e.m.u., $h = (6 \cdot 625 \pm 0.04\%) \times 10^{27}$ erg.sec. Using these in conjunction with the velocity of light *in vacuo* $(hc/2\pi e^2) = 137 \cdot 04 \pm 0 \cdot 02\%$. D. R. H.

424. Electronic Charge from Viscosity of Air. G. B. Banerjea and B. Plattanaik. *Zeits. f. Physik,* 110. 11–12. *pp.* 676–687, 1938.—An accurate determination of the viscosity of air based upon flow through a capillary tube is carried out. Instantaneous pressure readings were taken by means of an optical manometer working on an interference principle. Results obtained give the viscosity of air at 23° C. at $1833 \cdot 3 \pm 2 \cdot 2 \times 10^{-7}$ c.g.s. units and the temperature coefficient $4 \cdot 95 \times 10^{-7}$ c.g.s. units per degree. Substitution of this value of the viscosity in Millikan's oil-drop experiment leads to a value of $e = 4 \cdot 811 \pm 0 \cdot 009 \times 10^{-10}$ e.s.u., in good agreement with X-ray values, but rather larger than the most probable value recently reported by Millikan [see Abstract 3832 (1938)]. A. G. Q.

425. Interaction of Elementary Particles. Part IV. H. Yukawa S. Sakata, M. Kobayasi, and M. Taketani. *Phys. Math. Soc. Japan, Proc.* 20. *pp.* 720–745, *Sept.*, 1938.—The theory of the heavy neutral quantum [see Abstract 3000 (1938)] is extended by assuming the same equations for the neutral quantum as for the charged quantum and that the interaction of a heavy particle with each is the same, with the exception of the form of certain factors. An extended treatment is given of the deuteron problem, the interaction of the U-field with the light particle, the theory of β-disintegration, and the spontaneous annihilation of a heavy quantum. The problem of the creation of the heavy quantum by the following process is discussed in detail: a light quantum of energy greater tham $m_u c^2$ is absorbed by the neutron and a heavy quantum with negative charge is subsequently emitted, the neutron being transformed thereby into the proton. Results indicate that the hard cosmic-ray component observed at sea level may consist mainly of heavy quanta produced in the atmosphere from the soft component by the above process. The probability of heavy quanta by the inverse process is also calculated, and the problem of the spin and magnetic moment of the heavy quantum is discussed. N. M. B.

426. Diffuse Electron Diffraction Patterns. J. T. Burwell. *J. Chem. Phys.* 6. *pp.* 749–751, *Dec.* 1938.—Diffuse electron diffraction patterns taken by reflection have in the past been cited as proof that the polished surfaces of metals are amorphous or very finely crystalline. In the present work it is shown that such patterns can be obtained from a large-grained crystalline surface and hence cannot be due to an amorphous phase but rather to the physical contour of the surface. AUTHOR.

427. Slow Electron Scattering and Apparent Electron Affinity of Mercury. J. H. Simons and R. P. Seward. *J. Chem. Phys.* 6. *pp.* 790–794, *Dec.*, 1938.—The scattering of slow electrons by gaseous molecules is discussed with the object of explaining the curves obtained when the apparent scattering area is plotted against a function of the electron velocity. The peaks frequently observed at about the ionisation potential for most substances and the abnormally high values for the alkali metals are explained as being due to the formation or presence of positive ions. The rise in the curves for some substances, as the accelerating potential is diminished below the ionisation potential, is explained as the result of an attractive force between the electron and the neutral molecule. It is shown that this attractive force for Hg approximates an inverse fourth-power law. From this law and an assumption of the diameter of the negative Hg ion, a reasonable value for the apparent electron affinity of Hg is calculated. AUTHORS.

428. Elastic Scattering of Yukawa Particles. Part I. O. Laporte. *Phys. Rev.* 54. *pp.* 905–912, *Dec.*, 1, 1938.—Elastic scattering of the heavy particle obeying Bose statistics is examined by the relativistically invariant equations recently developed by Proca and by Dirac. Perturbation calculus of the " variation of constants " type is applied. For the evaluation of certain sums occurring in the scattering cross-sections, destruction operators are constructed similar to those first developed by Weisskopf for the Dirac equation. While according to Mott's calculation of the scattering of electrons a polarisation effect does not occur until the second approximation, such an effect appears in the present case even in the first approximation. The second approximation will be treated in a later paper. AUTHOR.

429. Secondary Electron Emission. Parts II and III. H. Bruining. *Physica*, 5. *pp.* 901–917, *Dec.*, 1938. *In English.*—It is demonstrated that the absorption of secondary electrons may be the cause of the fact that, with perpendicularly incident primary electrons, the secondary emission of metals with a large atomic volume is lower than that of metals with a small atomic volume. The absorption can be measured indirectly by allowing the primary electrons to strike the target at an angle of incidence greater than 0° ; the results of the experiments show that this hypothesis is probably correct. Upon bombardment with very slow electrons ($V_p =$ ca. 10V) the electropositive elements (Ba) have a higher secondary electron emission that metals such as Ag. The coefficient of elastic reflection of Ba is less than that of Ag. Compounds of the electropositive elements have a high capacity for secondary emission and for reflection. [For Part I see Abstract 860 (1938).] AUTHOR.

430. Behaviour of Electrons in Iodine Vapour. R. H. Healey. *Phil. Mag.* 26. *pp.* 940–953, *Dec.*, 1938.—The motion of electrons in I_2

vapour is studied by methods similar to those used in the case of Cl_2 and Br_2 vapour [see Abstract 3699 (1937)]. Curves are obtained showing the variation with *u* (the mean velocity of agitation of an electron) of (1) the mean free path of an electron in the gas at 1 mm. pressure, (2) the mean proportion of its energy lost by an electron in collision with a gas molecule and (3) the probability of attachment of an electron to the molecule with which it collides. Values of Townsend's energy factor, the drift velocity of an electron, and the probability of attachment of an electron per unit length of drift at unit pressure are plotted as ordinates of curves having Z/p as abscissæ, Z denoting the electric intensity and *p* the pressure. The results agree with those found by independent observers for gas mixtures containing I_2, and show that the three halogens Cl_2, Br_2 and I_2 have very similar properties. J. S. G. T.

431. Neutron Groups. Y. Sugiura and O. Minakawa. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers. No.* 842. *pp.* 1299–1307, *Oct.*, 1938. *In English.*—A neutron source consisting of solid D_2O cooled by liquid air and bombarded by 600 V deuterons is used, with standard Geiger-Müller light Al tube counter shielded from slow neutrons by 1 cm. B_2O_3 and from γ-radiation by 10 cm. Pb, 40 cm. away. Resonance groups are detected by interposing 1·5 mm. paraffin plates, and subsequent analysis of the activity curve. Results are quoted for In, I, Rh, Ag. D. R. H.

432. Emission of Neutrons from Substances Rich in Hydrogen. S. Flügge. *Zeits. f. Physik,* 111. 1–2. *pp.* 109–124, 1938.—In a theoretical paper a process is described for the calculation of the distribution of the resonance neutrons in a paraffin shell. The process has been extended to the diffusion theory of thermal neutrons. It is shown that for resonance neutrons within wide limits, the Fermi $1/v^2$ law is valid not only for the entire shell but also for each region within the shell. Further the constants hitherto determined indirectly, can be derived from a comparison with the empirical material. The value obtained for the free wavelength of resonance neutrons in water is 1·6 cm. instead of 1·3 cm.; while the value for the life of thermal neutrons is $3 \cdot 4 \times 10^{-4}$ sec. compared with the previous figure of $2 \cdot 7 \times 10^{-4}$ sec. In order to interpret the distribution curve of resonance neutrons it is suggested that the empirical curve should be thought of as a combination of the resonance groups with the thermal neutrons which have been incompletely absorbed by the Cd filter. G. O. B.

433. Photographic Effects Produced by Cd and other Elements under Neutron Bombardment. J. G. Hoffman and R. F. Bacher. *Phys. Rev.* 54. *pp.* 644–645, *Oct.* 15, 1938.—Briefly discusses the blackening obtained when a duplitised X-ray film has Cd placed next to it, and is then surrounded by paraffin and exposed to a neutron bombardment. It is shown that this blackening is due to slow neutrons. Also Cd has been compared with C, Al, Ni, Mo, Sn, W and Pb, the foils having thicknesses which contained the same number of atoms/cm². Blackening is obtained in every case, increasing with atomic number, but the blackening with Pb is considerably less than with Cd. R. C. F.

434. Soft Radiation Emitted on Capture of Neutrons by Nuclei. B. Pontecorvo. *Comptes Rendus,* 207. *pp.* 856–857, *Nov.* 7, 1938.—With a similar arrangement [see Abstract 974 (1937)] radiation reduced to one-half by 0·03 mm. Al was obtained with Cd (0·03 mm.) or Au (0·01 mm.). The behaviour of the radiation implies that it consists of soft electrons, and that it is connected with the strong absorption of thermal neutrons by Cd. It is concluded that it results from internal conversion. A further result of the foregoing is that a counter with thin Cd is a very sensitive detector of thermal neutrons. C. A. S.

435. Absorption Coefficients of Slow Neutrons. F. Norling. *Arkiv f. Mat. Astron. och Fysik, Stockholm,* 26*B*. 11. [8 *pp*.], 1938. *In German.*—A correction is worked out to allow for the non-parallel nature of neutron beams used in neutron absorption measurements. It is shown that allowance must be made for the breadth of the absorption bands in the detector itself when detection is effected by noting the induced β-ray activity. F. C. C.

436. Magnetic Scattering of Neutrons. P. N. Powers. *Phys. Rev.* 54. *pp*. 827–838, *Nov.* 15, 1938.—Owing to the magnetic moment of the neutron, a beam of neutrons transmitted through or scattered from a magnetised iron plate becomes polarised by selective scattering. The dependence of observed polarisation on thickness of iron has been shown to agree with the theories of Block and Schwinger. The effective cross-sections of iron for neutrons of spin $+\frac{1}{2}$ and $-\frac{1}{2}$ have been determined to be $13\cdot7 \times 10^{-24}$ and $10\cdot3 \times 10^{-24}$ cm^2. for $\sim 300°$ K neutrons, and $14\cdot1 \times 10^{-24}$ and $9\cdot9 \times 10^{-24}$ cm^2. for $\sim 120°$ K neutrons. Neutron polarisation has also been studied through the change in neutron intensity when a beam of neutrons partially polarised by transmission through one plate of magnetised iron is scattered from or transmitted by a second iron plate magnetised parallel or anti-parallel to the first. The neutron magnetic moment has been shown to be negative in sign and to be 2 ± 1 nuclear magnetons in magnitude. F. C. C.

437. Electron Optics. Cotte. *Ann. de Physique,* 10. *pp*. 333–405, *Oct.*, 1938.—A number of theoretical researches on electron optics are described. The analogies between geometrical and electron optics are traced and definitions are given of electron-optical wave surfaces and refractive indices. A study is made of the paths of electrons in magnetic and electrostatic fields for the general case and the aberrations and the dispersion of orthogonal systems are derived. The Gauss approximation for axially symmetrical systems is examined and certain features of these systems are studied by means of wave mechanics. H. J. H. S.

438. Theory of Electron Motion in Deflecting Condenser. A. Recknagel. *Zeits. f. Physik,* 111. 1–2. *pp*. 61–78, 1938.—The trajectories of electrons passing through an electrostatic deflecting condenser are calculated. For small deflecting voltages the deflection is proportional to voltage and independent of angle of entry and the condenser is analogous to a small angle optical prism. For higher deflecting voltages, corresponding to a large angle prism, the deflection is proportional to voltage plus a small correction term dependent on the cube of the voltage. For large voltages the condenser has a focusing action on a parallel beam of electrons, in contrast to the optical prism ; the focusing effect is defined by the integral of the square of the field and is thus unavoidable. Focal length formulæ are derived. J. E. K.

439. Focusing of Charged Particles by Spherical Condenser. E. M. Purcell. *Phys. Rev.* 54. *pp*. 818–826, *Nov*. 15, 1938.—If a beam of homogeneous charged particles traverses a portion of a spherical condenser to which a suitable potential is applied, a focusing action may be obtained. The whole of the condenser gap may be used as a large aperture monochromator. The expressions for the dispersion are of simple form. Compensation for the edge effect is discussed as well as the relativistic modifications necessary for high speed particles. An analyser of aperture 0·210 is described which requires a total focusing potential of 0·315 E where E is the particle energy in equivalent volts; the theoretical reduced dispersion is 1010. The performance of this analyser is briefly described; one disadvantage is its inherent difficulty of construction. H. J. H. S.

See also Abstracts 236, 237, 241, 242, 266, 370 and
53B. Ultradynamic Overcontrol of Kathode-Ray Tubes. H. E. Hollmann.

ELECTROSTATICS.

***440. Electrostatic Machines. W. Kossel.** *Zeits. f. Physik,* 111. 3–4. *pp.* 264–280, 1938.—A discussion is given of the structure and mode of action of various types of electrostatic machine, including considerations on the need of space and the danger of disturbances of the smooth surfaces of the high tension body. J. J. S.

See also Abstract 219.

MAGNETISM AND ELECTROMAGNETISM.

441. Total Action of Magnetic Forces in Isotropic Systems. L. Roy. *Comptes Rendus,* 207. *pp.* 659–661, *Oct.* 17, 1938.—The author discusses the separation of the forces and moments on magnetic bodies into those due to the actual magnetisation and those due to electric currents. W. S. S.

442. Electromagnetic Energy of a Point Charge. M. H. L. Pryce. *Roy. Soc., Proc.* 168*A*. *pp.* 389–401, *Nov.* 7, 1938.—A suggested method is developed for removing from classical electromagnetic theory the difficulty that the electromagnetic energy becomes infinite in the neighbourhood of the point charge. This is done by introducing into the energy integral an additive vector-field, depending only on the variables of the charge, in such a way as to make the whole integral finite at the point charge. A relativistic treatment of the problem is given. The additional vector field may be regarded roughly as a negatively infinite energy arising from the charge itself. G. C. McV.

443. Preparation of Various Magnetic Products from FeOOH. R. Forrer. *Comptes Rendus,* 207. *pp.* 670–671, *Oct.* 17, 1938.—FeOOH obtained by hydrolysis of FeOCl by NH_4OH is not ferromagnetic. On heating it loses H_2O, and the product may become ferromagnetic according to the conditions under which the heating is carried out. When rapidly heated a weak ferromagnetism appears and disappears again in the region of 275°. On slow heating, a strong ferromagnetism develops at 250–275°, the product having a Curie point at 350°. Above 275° a second ferromagnetic state is formed with a Curie point at 520°. Prolonged heating at 600° gives a non-ferromagnetic product. All four products have the composition Fe_2O_3. The crystal structure of each has been determined. A. J. M.

444. Ferromagnetic Cr Compounds. L. F. Bates and G. G. Taylor. *Phys. Soc., Proc.* 51. *pp.* 33–36, *Jan.* 1, 1939.—It is found that when powdered Cr prepared from Cr amalgam is heated with S *in vacuo,* a series of ferromagnetic compounds is formed. The Curie points and specific magnetisations of the prepared specimens are recorded. AUTHORS.

445. Alloys of Fe with Metals of the Pt Group. Fallot. *Ann. de Physique,* 10. *pp.* 291–332, *Oct.,* 1938.—A study of the magnetic properties of alloys of iron with Pt, Ir, Os, Ru, Rh and Pd. The alloys were prepared with concentrations including the range over which these bodies are ferromagnetic. The range is narrow in the cases of Ir, Os and Ru; the ferromagnetic limit for these is also the limit of solid solution with centred cube lattice. In Rh this structure persists up to very high concentrations of the precious metal. With Pt and Pd ferromagnetic alloys are formed having cubical structure with centred faces. Change of phase was determined from the Curie points and from the transformations; these were confirmed by X-ray tests. The properties of these last alloys recall those of the ferronickels. The ferromagnetic moments are such that the mean atomic moment diminishes less rapidly than if iron atoms of constant moment were mixed with atoms of zero moment. With Fe/Ir, Fe/Pt and Fe/Rh the mean atomic moment increases with the content of rare metal. The results obtained with Pt and Rh are such that, from the just stated point of view, their alloys are comparable with ferrocobalts containing 30% Co. G. E. A.

446. Magnetic and Thermal Properties of a Solution of Na in Liquid NH_3. E. Huster. *Ann. d. Physik*, 33. 6. *pp.* 477–508, *Nov.*, 1938.—An apparatus is described for obtaining samples of Na dissolved in liquid NH_3 by decanting *in vacuo* (the solution is rapidly attacked by air). The magnetic susceptibility of solutions of varying concentration is measured at temperatures ranging from − 35 to − 75° C., the value being calculated by the mixture rule. The atomic susceptibility at high concentrations (6–7 NH_3/Na) is about 6 times as great as that of metallic Na at room-temperature whilst from − 75 to − 35° C. it slowly increases, the temperature effect decreasing with increasing concentration. At low concentrations ($3 - 6 \times 10^4$ NH_3/Na), the susceptibility reaches a value at − 35° C. which corresponds to approximately 1 Bohr magneton per atom; this value is again reached at − 75° C. for a concentration 6 times less. At temperatures between − 75 and − 35° C. the solution is strongly diamagnetic; this is accounted for by the fact that the solution contains Na_2 molecules. An attempt is made to explain the experimental results and in addition a number of other properties of the solutions are discussed. [See also Abstract 1332 (1938).] H. J. H. S.

447. Crystalline Diamagnetism of Thallium. S. R. Rao and A. S. Narayanaswami. *Phil. Mag.* 26. *pp.* 1018–1030, *Dec.*, 1938.—A study is made of the principal diamagnetic susceptibilities of Tl containing small admixtures of Cd, Pb, Sn and Bi. While Cd increases the magnetic anisotropy of Tl, the other metals decrease this value Although Pb and Sn contain the same number of valence electrons, Sn is 2·5 times as effective as Pb in reducing the magnetic anisotropy. Attention is drawn to the similarity of these observations with those on Bi by Goetz and Focke and by Shoenberg and Uddin. Cold-working of Tl is accompanied by a reduction of its magnetic anisotropy. AUTHORS.

448. Analogy between Forces on Currents and Magnetic Forces. L. Roy. *Comptes Rendus*, 207. *pp.* 698–700, *Oct.* 24, 1938.—Expressions are derived for the resultant forces and moments exerted by electric currents and magnetisation on the currents in a system of isotropic bodies. [See following Abstract.] W. S. S.

449. Electric Forces in a System of Isotropic Bodies. L. Roy. *Comptes Rendus*, 207. *pp.* 757–759, *Nov.* 2, *and pp.* 826–828, *Nov.* 7, 1938.—Expressions are developed for the resultant forces and moments on rigid and deformable dielectrics due to electric forces on the free charge and dielectric polarisation. [See preceding Abstract.] W. S. S.

450. Magnetisation of Ferromagnetics under Tension. E. Kondorsky. *Comptes Rendus* (*Doklady*) *de l'Acad. des Sciences, U.S.S.R.* 20. 2–3. *pp.* 117–120, 1938. *In English.*—Describes measurements of susceptibility, reversible susceptibility and residual magnetism in Ni-Fe alloys with and without applied stress. Susceptibility and residual magnetism in weak fields are found to be much greater when the specimen is demagnetised in the unstressed state, then stressed and magnetised without reversal of current, than when magnetisation is carried out with continuous current reversals or when the specimen is demagnetised under stress and then magnetised either with or without current reversals. These effects are explained in terms of the behaviour of the domains under the influence of external stress and reversals of magnetising field. The results show that demagnetisation in the unstressed state and subsequent loading facilitate magnetisation in weak fields and produce initial states in hard materials with positive magnetostriction which are otherwise only obtainable after annealing. C. E. W.

***451. Current Balance for Measuring Magnetic Fields and Susceptibility. A. R. Kaufmann.** *Rev. Sci. Instruments*, 9. *pp.* 369–371, *Nov.*, 1938.—The current balance consists of a long single-layer coil suspended from a balance-arm and with its axis coincident with the direction of the field. One end of the coil is in the field to be measured and the other in a weak field which, if not negligibly small, must be measured approximately, *e.g.*, by means of a search-coil. An expression, analogous to that for the Gouy method of susceptibility measurement, is obtained for the force on the coil in terms of the coil constants, current in the coil and field strength. Precautions for attaining the maximum accuracy are described and an absolute accuracy of 1 part in 1000 or even better is claimed. The instrument can be applied to measure susceptibility by placing the specimen inside the coil and adjusting the current in the coil to balance the force on the specimen. C. E. W.

See also Abstracts 16, 58, 153, 287, 340, 364, 385.

MEDICAL RADIOLOGY AND ELECTROLOGY.

***452. X-Ray Screen Image Photography. H. Steps.** *Phot. Indust.* 36. *pp.* 1138–1140, *Oct.* 19, 1938.—The high cost of ordinary radiographic films in the large sizes of 35 × 35 cm. and 40 × 40 cm. has hitherto precluded any extensive serial investigation involving, *e.g.*, the taking of thorax radiographs of 10,000 different subjects. However, recent technical improvements in the output of X-ray generators, the efficiency of fluorescent screens, photographic lenses and negative material has made X-ray kinematography possible by the indirect method, in which a kinematograph film is taken of the fluorescent screen image. The author has now evolved a system, by means of which serial thorax radiographs may be photographed on miniature film sizes 23 × 32 mm. or 32 × 42 mm. at the rate of 60 an hour for a very low cost. A Super-Astral fluorescent screen size 30 × 40 cm. is fixed at 150 cm. from the anode of an X-ray tube which is energised for 0·22 sec. with 500–600 mA at 50–57 kV. The screen image is then photographed by a miniature film camera 100cm. from the screen, using a Zeiss Biotar lens, $f = 1{\cdot}4$. A film negative material is chosen having a spectral intensity response to match the output of the fluorescent screen. The reduction in image size is 13 fold but 36 pictures may be taken on each section of film, which after development under standard conditions is then projected and enlarged

10–15 times, though if necessary it is claimed that the picture may be enlarged 40 times without essential loss of detail. Some typical thorax radiographs are illustrated. It is hoped by the use of this system to commence a serial radiographic investigation of the whole German nation. T. A. C.

453. Barium Sulphate Suspension in Colloidal Aluminium Hydroxide. E. E. Woldman. *Am. J. of Roentgenology and Radium Therapy*, 40. *pp*. 705–707, *Nov.*, 1938.—In examinations of the alimentary canal by means of a $BaSO_4$ meal, suspension of the $BaSO_4$ by addition of $Al_2(OH)_6$ is recommended, as such a preparation better fills the recesses of the bowel wall and allows better radiographic visualisation of the folds of the mucosal lining. The preparation is non-toxic, does not disturb the acid-base equilibrium of the blood and does not render the meal less palatable to the patient. B. J. L.

454. Control and Calibration of X-Ray Apparatus. C. Weyl, D. B. O'Neill and S. R. Warren, Jr. *Am. J. of Roentgenology and Radium Therapy*, 40. *pp*. 741–758, *Nov.*, 1938.—For production of comparable radiographs the apparatus construction, maintenance and technique factors are complicated. The radiograph is dependent upon the exposure time, tube current, tube voltage, distance between target and film, the particular tube, the intensifying screens and cassettes, the actual film and the processes of its development, etc. Each of these factors is discussed in great detail in respect to the precise control of apparatus and technique, accurate calibration of the technical factors and the use of an aluminium ladder scale to permit exact reproduction of film density and contrast. The particular technique has been utilised in chest radiography and is capable of extension to other spheres of radiography. B. J. L.

455. D.C. Sensitisation to X-Rays. J. R. Carty. *Radiology*, 31. *pp*. 414–417, *Oct.*, 1938.—Experiments have been made on the action of d.c. on animal tissues with a response varying from a barely perceptible reaction to complete destruction of normal tissue, with a view to studying any artificial sensitisation to X-rays that may ensue. In a typical experiment a current of 5 mA at 30 V was applied to the shaved skin of Belgian hares by means of Pt electrodes surrounded by gauze moistened in isotonic saline solution, using a current flux per unit area insufficient to cause necrosis. At the kathode an alkaline reaction was produced with vasodilation and irritation, while at the anode there was an acid reaction and vaso-constriction and sedation. The production of heat was common to both electrodes. In a subsequent experiment, this treatment was combined with irradiation by unfiltered X-rays generated at 100 kV peak given at a focus-skin distance of 20 cm. Applying a dose of 1500–2000 r. in 25 min. it was found that in normal rabbit tissue, the kathode consistently showed a greater reaction than that of the control area, indicating a definite sensitisation in a region which gradually fades beyond the limit of the electrode. The anode, however, showed inconsistent results, the reaction being slightly diminished. It is concluded that the use of d.c. to intensify the effect of external irradiation in the treatment of malignant disease has at least a logical as well as an experimental background. T. A. C.

456. Seventeen Years' Experience in Radiation Therapy of Cancer, Zurich, 1919-1935. H. R. Schinz. *Am. J. of Roentgenology and Radium Therapy*, 40. *pp*. 485–496, *Oct.*, 1938.—Largely of statistical information respecting the author's personal results of treatment of all

forms of cancer by Ra and X-rays. Of 2529 patients favourable therapeutic results have been obtained in 70% of cases. The results obtained are stated to be only possible when the radiologist is also the clinician.
B. J. L.

457. **Effect of Wall Materials in Ionisation Measurement of X-Rays. H. Hase and H. Küstner.** *Phys. Zeits.* 39. *pp.* 737–742, *Nov.* 1, 1938.—In a series of cylindrical ionisation chambers of diameters 5·8, 12·4 and 30 cm. the effect of the wall material (graphited cellophane, Al, Cu, Brass and Pb) on the ionisation has been investigated in relation to the quality of the radiation. The relative ionisation increases with the atomic number of the wall material and decreases as the dimensions of the chamber increase; increasing half-value-layer of the radiation leads to an increase in the ionisation. In the case of the smallest chamber the ionisation h.v.l. curve shows a maximum and a minimum. A new type of chamber independent of wave-length is suggested. By constructing composite walls of heavy and light elements the opposing effects of chamber size and atomic number compensate, the variations in the ionisation up to a half-value-layer of 2 mm. Cu being less than 1%. J. E. R.

458. **Ten Years' Experience in the Standardisation of the Roentgen. H. Küstner.** *Phys. Zeits.* 39. *pp.* 743–761, *Nov.* 1, 1938.—A very detailed survey has been made of all the factors affecting the accuracy and constancy of the standard X-ray ionisation chambers and accessory apparatus at Göttingen, which have been in use for the past 10 years. J. E. R.

*459. **Influence of a Lead Cone on Intensity Distribution of a Two-Gramme Radium Beam Unit. F. W. Spiers.** *Brit. J. of Radiology*, 11. *pp.* 825–830, *Dec.*, 1938.—A cone unit, based upon principles put forward by Benner, has been designed for a Ra beam unit having a single ring arrangement of Ra containers. The depth dose is thereby increased more efficiently than by the alternative method of increasing the Ra-skin distance, and an improved definition of the γ-ray beam is obtained. Results for cones of various sizes illustrate the control exercised by certain cone dimensions. AUTHOR.

See also Abstracts 268 and

110B. H.F. Heating of Biological Tissues. K. H. Spiller.
111B. Short-Wave Diathermy. A. Amweg.

OSCILLATIONS AND WAVES.

*460. **Characteristics of a Split-Anode Magnetron Oscillator as a Function of Slot Angle. L. Rosen.** *Rev. Sci. Instruments*, 9. *pp.* 372–373, *Nov.*, 1938.—One of the design considerations in the split-anode magnetron is the slot angle, *i.e.*, the angle subtended by the slot at the anode axis. The results of an experimental determination of the effect of the slot angle on the power output and efficiency of a negative-resistance magnetron oscillator operating with a constant anode current are given in this paper. It was found that the curve of power output *vs.* slot angle has a broad maximum between 15 and 30°. AUTHOR.

*461. **Production and Frequency Measurement of Currents of 10 to 100 ∼. A. L. Clark and L. Katz.** *Canad. J. of Research*, 16. *Sect. A. pp.* 183–189, *Sept.*, 1938.—A l.f. dynatron oscillator with a range of 10 to 100 ∼ and a power output of 10 W is described. The frequency is measured by taking photographs, at intervals of 1 sec., of two pointers on a small synchronous motor powered by the current whose frequency is to be measured. The stability of the oscillations and the accuracy of the frequency measurements are such that frequencies may be maintained and measured to 1 part in 30000, over a period of several hours. AUTHORS.

462. Critical-Frequency Method of Measuring Upper-Atmospheric Ionisation. E. V. Appleton, R. Naismith and L. J. Ingram. *Phys. Soc., Proc.* 51. *pp.* 81–92, *Jan.* 1, 1939.—The formulæ normally employed in the application of the critical-frequency method of measuring upper-atmospheric ionisation are examined and are shown to be appropriate in the case of ionospheric regions which are thick when measured in terms of a wave-length. The complications arising from the occurrence of ionised clouds or strata embedded in the normal regions are described and interpreted. AUTHORS.

463. Limiting Polarisation of Medium Waves Reflected from the Ionosphere. T. L. Eckersley and G. Millington. *Phys. Soc., Proc.* 51. *pp.* 110–128, *Jan.* 1, 1939.—A method is described of measuring the polarisation of a downcoming radio wave which has been reflected obliquely from the ionosphere. Two rotatable crossed loops are adjusted to be in quadrature by dephasing one forwards and the other backwards 45° from resonance. With the usual goniometer technique the search coil gives zero pick-up when the tangent of the angle at which it is set is equal to the ratio of the axes of the projected polarisation ellipse, and the frames are turned so that their planes are along the axes of this ellipse. Results obtained on medium-wave broadcasting stations are compared with ellipses calculated on the magneto-ionic theory for an assumed angle of emergence and direction of the earth's magnetic field. The comparison shows that, within the present accuracy of the apparatus, the absorption due to electronic collisions does not appreciably affect the limiting polarisation of the emergent wave, and sets an upper limit of 10^6 per sec. to the collisional frequency in the region where the polarisation assumes its limiting value. The experiments also suggest that the ratio of the number of ions to the number of electrons in this region is not greater than 10,000, and further work with increased accuracy should give valuable information relevant to the inclusion of the Lorentz term in the magneto-ionic theory for the E-layer. AUTHORS.

464. Origin of Radio-Wave Reflections in the Troposphere. J. H. Piddington. *Phys. Soc., Proc.* 51. *pp.* 129–135; *Disc.*, 136–137, *Jan.* 1, 1939.—The evidence relating to the reflection of radio waves in the lower atmosphere is critically examined. It is shown that reflection is most probably due, not to ionised layers as was previously supposed, but to discontinuities in the concentration and state of the water content. It is considered probable that all reflections causing echoes of semi-path less than about 25 km. (B-region echoes) take place within the troposphere. AUTHOR.

465. Theoretical Ionisation Curves for the E-Region. M. V. Wilkes. *Phys. Soc., Proc.* 51. *pp.* 138–146, *Jan.* 1, 1939.—This paper contains some ionisation curves for the E-region based on Chapman's theory of the solar ionisation of a rotating atmosphere, and calculated mechanically by means of a Bush differential analyser. An attempt is made to reproduce the experimental results obtained by Best, Farmer and Ratcliffe in Cambridge [see Abstract 375 (1938)], and it is found necessary to assume a greater rate of recombination during the day than during the night. This assumption is confirmed by some curves calculated for observations made at Washington on Aug. 31, 1932, when an eclipse of the sun took place. The observational data have been published by Kirby, Gilliland and Judson. AUTHOR.

See also Abstracts 78, and

175B. Long-Period Variations in F_2-Region. K. Tani, Y. Ito and H. Sinkawa.
176B. Limit Waves and Ionosphere. Part III. O. Burkard.
177B. Quasi-Optics of Wave Guides. H. Buchholtz.
191B. Coupling of Oscillating Circuit with Geissler Tube. T. V. Ionescu.

PHOTOELECTRICITY.

466. Influence of Electrode Material on Sensitivity of Se Rectifier Cells. P. Görlich and W. Lang. *Zeits. f. phys. Chem.* 41. *Abt. B.* 1. *pp.* 23–32, 1938.—For the transparent electrode in Se rectifier cells a number of different metals was tried, deposited both by evaporation and by sputtering where possible. From the results it is inferred that the introduction of suitable "excitation-centres" in the Se film leads to increased sensitivity. Such an increase is established for "excitation-centres" of Cd. D. H. F.

467. Action of Soft X-Rays upon Selenium Barrier-Layer Cells. A. E. Sandström. *Phil. Mag.* 26. *pp.* 906–920, *Nov.*, 1938, *Supplement.*—As regards photo-current and photo-voltage Se barrier-layer elements respond to soft X-rays of the wave-length region 3·5–20 Å mainly in the same way as to visible light. In one case an element showed a remarkable deviation of the current-intensity curves from the straight line for small intensities. When exposed to soft X-rays the barrier-layer resistance was found to vary in a way not quite accounted for. The photo-currents are too small to allow the elements to be used for intensity measurements in a spectrally dispersed radiation. AUTHOR.

468. Photovoltaic Effects in Grignard Solutions. A. J. Harrison, D. Nightingale and R. T. Dufford. *Am. Chem. Soc., J.* 60. *pp.* 2450–2452, *Oct.*, 1938.—Mg amalgam electrodes gave zero dark voltage and no light sensitivity with ether solutions of either phenyl-magnesium bromide or ethyl-magnesium bromide. Mg electrodes which had been cleaned by reacting with the organic halide gave the same results. Mg electrodes which had not been cleaned in this manner showed variable dark voltages and variable photovoltaic responses. Both of these could be destroyed by adding the organic halide or by allowing the cell to stand for several days. " Cleaned " Mg electrodes were made sensitive to light by exposure to O_2. AUTHORS.

PIEZOELECTRICITY.

See Abstract 68.

THERMIONICS.

469. Field Emission from Layered Kathodes under Electron Bombardment. Part II. H. Mahl. *Zeits. f. techn. Physik,* 19. 10. *pp.* 313–320, 1938.—Continuing previous work [see Abstract 1363 (1938)], further results are obtained on the secondary field emission from layered kathodes of $Al\text{–}Al_2O_3\text{—}Cs_2O$. The field emission rises to a flat maximum when the primary electrons have an energy greater than about 15 eV; the curve returns to zero at about 1000 eV. The result of giving a negative charge to the upper layer was also examined. F. C. C.

THERMOELECTRICITY.

See Abstract 231.